DFCM REGIONAL CENTER
FARMINGTON

577 N LAGOON DRIVE

FARMINGTON, UT 84025

specifications | project manual

June, 2024

prepared by;
ajc architects
703 east 1700 south, salt lake city, utah 84105
project no. 2023.38

ajc architects

DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

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SECTION 000103 - PROJECT DIRECTORY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Identification of project team members and their contact information.

1.02 OWNER:

A. Name: Division of Facilities and Construction Management

1. Address Line 1: 4315 South 2700 West.
2. City: Taylorsville.
3. State: Utah.
4. Zip Code: 84129.
5. Telephone: 801.706.5966.

B. Primary Contact: All correspondence from the Contractor to the Architect will be direct , unless alternate arrangements are mutually agreed upon at preconstruction meeting.

1. Title: Project Architect.
2. Name: Dijana Rambo.

1.03 CONSULTANTS:

A. Architect: Design Professional of Record. All correspondence from the Contractor regarding construction documents authored by Architect's consultants will be through this party, unless alternate arrangements are mutually agreed upon at preconstruction meeting.

1. Company Name: ajc architects.

a. Address Line 1: 703 East 1700 South.
b. City: Salt Lake City.
c. State: Utah.
d. Zip Code: 84105.
e. Telephone: 801.466.8818.

2. Primary Contact:

a. Title: Principal.
b. Name: Diajna Rambo.
c. Email: dijana@ajcarchitects.com.

B. Civil Engineering Consultant:

1. Company Name: Meridian Engineering.

a. Address Line 1: 1628 West 11010 South, Ste. 102.
b. City: South Jordan.
c. State: Utah.
d. Zip Code: 84095.
e. Telephone: 801.569.1315.

2. Primary Contact:

a. Title: Project Manager.
b. Name: Mark Cook.

C. Landscape Architecture Consultant:

1. Company Name: Arcsitio Design.

a. Address Line 1: 1058 East 2100 South.
b. City: Salt Lake City.
c. State: Utah.
d. Zip Code: 84106.
e. Telephone: 801.487.4923.

2. Primary Contact:

a. Title: Principal.
b. Name: Steve Gilbert.

D. Structural Engineering Consultant:

1. Company Name: Reaveley Engineers.

a. Address Line 1: 675 East 800 South, #400.
b. City: Salt Lake City.
c. State: Utah.
d. Zip Code: 84102.
e. Telephone: 801.530.3148.

2. Primary Contact:

a. Title: Principal.

E. Mechanical Engineering Consultant - Plumbing / HVAC:

1. Company Name: WHW Engineering.

a. Address Line 1: 8619 South Sandy Parkway #101.
b. City: Sandy.

c. State: Utah.
d. Zip Code: 84070.
e. Telephone: 801.466.4021.

2. Primary Contact:

a. Title: Principal.
b. Name: Brad Lash.

F. Electrical Engineering Consultant:

1. Company Name: Spectrum Engineers.

a. Address Line 1: 324 South State St., Ste 400.
b. City: SaltLake City.
c. State: Utah.
d. Zip Code: 84111.
e. Telephone: 801.401.8474.

2. Primary Contact:

a. Title: Principal.
b. Name: Matt Haverkamp.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 000103

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FARMINGTON, UT 84025

DOCUMENT 000107 Include on this Seals Page Document the seals of the design professionals of record required by statute to affix their seal to the documents. Where required, include a description of the Specification Sections prepared under the direction of each design professional.

1.1 DESIGN PROFESSIONALS OF RECORD

ARCHITECT
ajc architects
703 East 1700 South
Salt Lake City, Utah 84105
1.801.466.8818
Contact: Dijana Rambo



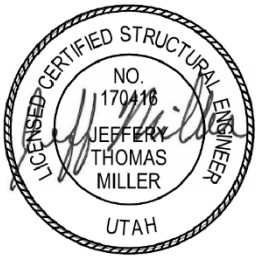
CIVIL ENGINEER
Meridian Engineering
5746 South 1475 East
South Jordan, Utah 84095
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Contact: Mark Cook



LANDSCAPE ARCHITECT
Arcistio
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Salt Lake City, Utah 84106
1.801.487.4923
Contact: Steven Gilbert

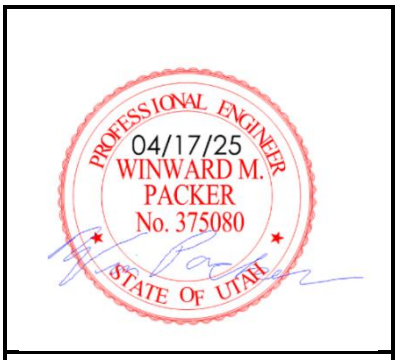


STRUCTURAL ENGINEER
Reaveley Engineers
675 East 500 South
Salt lake City, UT, 84102
1.801.486.3883
Contact: Jeff Miller

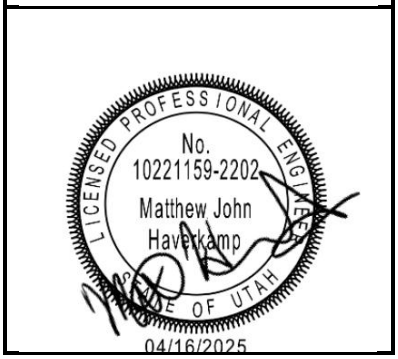


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MECHANICAL ENGINEER	**WHW engineering** 8619 south sandy parkway #101 Sandy, UT, 84070 801.466.4021 Contact: Brad Lash



ELECTRICAL ENGINEER	**Spectrum Engineers** 324 south state street, suite 400 Salt lake city, UT, 84111 801.401.8474 Contact: Matt Haverkamp



SECTION 003100 - AVAILABLE PROJECT INFORMATION

PART 1 GENERAL

1.01 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:

B. Geotechnical Report: Entitled Farmington Regional Center , dated July 3, 2024 .

1. A copy is available for viewing as appended to this Document.
2. This report identifies properties of below grade conditions and offers recommendations for the design of foundations, prepared primarily for the use of Architect.
3. The recommendations described shall not be construed as a requirement of this Contract, unless specifically referenced in Contract Documents.
4. This report, by its nature, cannot reveal all conditions that exist on the site. Should subsurface conditions be found to vary substantially from this report, changes in the design and construction of foundations will be made, with resulting credits or expenditures to the Contract Price accruing to Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 003100

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CMT TECHNICAL SERVICES



ENGINEERING •GEOTECHNICAL •ENVIRONMENTAL (ESA I & II) •
MATERIALS TESTING •SPECIAL INSPECTIONS •
ORGANIC CHEMISTRY • PAVEMENT
DESIGN •GEOLOGY

GEOTECHNICAL ENGINEERING STUDY

Farmington Regional Center

About 500 North Lagoon Drive
Farmington, Utah

CMT PROJECT NO. 22203

FOR:
ajc architects
703 East 1700 South
Salt Lake City, Utah 84105

July 3, 2024

CMT TECHNICAL SERVICES

July 3, 2024

Ms. Jill Jones
ajc architects
703 East 1700 South
Salt Lake City, Utah 84105

Subject: Geotechnical Engineering Study
Farmington Regional Center
About 500 North Lagoon Drive
Farmington, Utah
CMT Project Number: 22203

Ms. Jones:

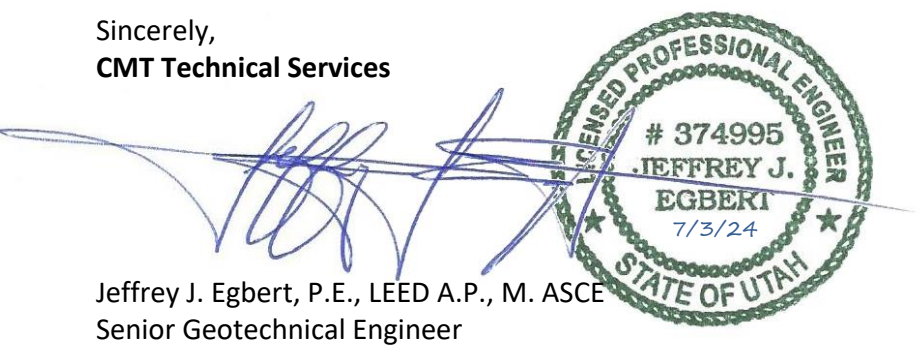
CMT Technical Services (CMT) submits herewith this geotechnical engineering study report for the subject site. This report contains the results of our findings and an engineering interpretation of the results with respect to the available project characteristics. It also contains recommendations to aid in the design and construction of the earth related phases of this project.

On May 24, 2024, a CMT staff professional was on-site and observed the drilling of 8 bore holes extending to depths of about 6.5 to 51.5 feet below the existing ground surface. Samples of the subsurface soils were obtained from within the bore holes during the field operations and subsequently transported to our laboratory for further observation and testing of select samples. Infiltration testing and Dynamic Cone Penetration (DCP) testing were also performed.

Conventional spread and/or continuous footings may be utilized to support the proposed structure, provided the recommendations in this report are followed. This report presents detailed discussions of design and construction criteria for this site.

We appreciate the opportunity to work with you at this stage of the project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With offices throughout Utah, Idaho, Arizona, Colorado and Texas, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at 801-590-0394.

Sincerely,
CMT Technical Services



Jeffrey J. Egbert, P.E., LEED A.P., M. ASCE
Senior Geotechnical Engineer

Reviewed by:

Andrew M. Harris, P.E.
Geotechnical Division Manager

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1.0 INTRODUCTION

1.1 General

CMT Technical Services (CMT) was retained to conduct a geotechnical subsurface study for the proposed Farmington Regional Center office building. The site is situated on the north side of Lagoon Drive at about 500 North in Farmington, Utah, as shown in **Exhibit 1 - Vicinity Map** below.



EXHIBIT 1 - VICINITY MAP

1.2 Objectives, Scope and Authorization

The objectives and scope of our study were planned in discussions between Ms. Jill Jones with ajc architects, and Mr. Andrew Harris of CMT. In general, the objectives of this study were to define and evaluate the subsurface soil and groundwater conditions at the site, and provide appropriate foundation, earthwork, pavement and seismic recommendations to be utilized in the design and construction of the proposed development.

In accomplishing these objectives, our scope of work has included performing field exploration, which consisted of the drilling/logging/sampling of 8 bore holes, performing laboratory testing on representative samples of the subsurface soils collected in the bore holes, performing an infiltration test in one of the bore holes, performing

Dynamic Cone Penetration (DCP) testing, and conducting an office program, which consisted of correlating available data, performing engineering analyses, and preparing this summary report. This scope of work was authorized through our master consultant agreement in relation to our proposal dated March 12, 2024.

1.3 Description of Proposed Construction

We understand that the proposed construction consists of an office building with a plan area of approximately 35,000 square feet, which will be 1 to 2 levels above grade. We project that wall loads will not exceed 6,000 pounds per linear foot and column loads will not exceed 100,000 pounds. Floor slab loads are anticipated to be relatively light, with an average uniform loading not exceeding 150 pounds per square foot. If the structural loading conditions are different than we have projected, please notify us so that any appropriate modifications to our conclusions and recommendations contained herein can be made.

We project that proposed light-duty parking areas and internal drive lanes will be surfaced with asphalt concrete pavement. Traffic is projected to consist of mostly automobiles and light trucks, a few daily medium-weight delivery trucks, a weekly garbage truck, and an occasional fire truck.

Site development will require some earthwork in the form of minor cutting and filling. A site grading plan was not available at the time of this report, but we project that maximum cuts and fills may be on the order of 3 to 4 feet. If deeper cuts or fills are planned, CMT should be notified to provide additional recommendations, if needed.

1.4 Executive Summary

The most significant geotechnical aspects regarding site development include the following:

1. Vegetation, including trees, and topsoil on the surface of the site, with roots observed extending up to 5 feet in depth in places. Topsoil and soil containing a significant organic content are to be removed from footing and floor slab areas.
2. Subsurface soils encountered consisted predominately of CLAY (CL) and SILT (ML), but some SAND (SM, SP-SM) layers, and an occasional GRAVEL (GP) layer were also encountered, extending to the maximum depth explored of 51.5 feet below the existing ground surface.
3. Groundwater was encountered in three of the eight bore holes at depths ranging between 9.5 and 21 feet below the existing ground surface.
4. Foundations and floor slabs may be constructed on suitable undisturbed natural soils or on structural/engineered fill which extends to natural soils.

CMT must assess that topsoil, undocumented fills (if encountered), debris, disturbed or unsuitable soils have been removed and that suitable soils have been encountered prior to placing site grading fills, footings, slabs, and pavements.

In the following sections, detailed discussions pertaining to the site are provided, including subsurface descriptions, geologic setting, seismicity, earthwork, foundations, lateral resistance, lateral pressure, floor slabs, and pavements.

2.0 FIELD EXPLORATION

2.1 Drilling

To define and evaluate the subsurface soil and groundwater conditions, 8 bore holes were drilled at the site to depths of approximately 6.5 to 51.5 feet below the existing ground surface and observed and logged by an experienced member of our geotechnical staff. Locations of the bore holes are shown on ***Figure 1, Site Plan***, included in the Appendix.

Samples of the subsurface soils encountered in the bore holes were collected at varying depths through the hollow stem drill augers. Relatively undisturbed samples obtained by hydraulically pushing a 3-inch diameter (Shelby) tube or by driving a split-spoon sampler with 2.5-inch outside diameter rings/liners, into the undisturbed soils below the drill augers. Disturbed samples were collected utilizing a standard split spoon sampler that was driven 18 inches into the soils below the drill augers using a 140-pound hammer free-falling a distance of 30 inches. The number of hammer blows needed for each 6-inch interval was recorded. The sum of the hammer blows for the final 12 inches of penetration is known as a standard penetration test and this 'blow count' was recorded on the bore hole logs. The blow count provides an approximation of the relative density of granular soils, but only a limited indication of the relative consistency of silt/clay soils because the consistency of these fine grained soils is significantly influenced by the moisture content.

The subsurface soils encountered in the bore holes were classified in the field based upon visual and textural examination, logged and described in general accordance with ASTM[1] D-2488. These field classifications were supplemented by subsequent examination and testing of select samples in our laboratory. Logs of the bore holes, including a description of the soil strata encountered, is presented on each individual Bore Hole Log, ***Figures 2 through 9***, included in the Appendix. Sampling information and other pertinent data and observations are also included on the logs. In addition, a Key to Symbols defining the terms and symbols used on the logs is provided as ***Figure 10*** in the Appendix.

Following completion of drilling operations, 1.25-inch diameter slotted PVC pipe was installed in bore holes B-1, B-3, and B-4 to allow subsequent water level measurements. The bore holes were backfilled with auger cuttings.

2.2 Dynamic Cone Penetration Testing

A Dynamic Cone Penetrometer (DCP) was used at the locations of bore holes B-2 through B-7 to assess the subgrade soil strength for pavement support characteristics. The DCP consists of an approximate half inch diameter steel rod driven into the soils with a weighted doughnut hammer. The number of millimeters of

[1] American Society for Testing and Materials

penetration per hammer blow is recorded. The data is then correlated to a California Bearing Ratio (CBR) value utilized for pavement design. Data obtained from the DCP testing is presented in **Section 11.0, Pavements** and shown on ***Figures 11 through 16***.

2.3 Infiltration Testing

Infiltration testing was also performed as part of our field exploration within bore hole B-8 at a depth of about 5 feet below the existing ground surface. The testing consisted of drilling to the specified depth, sampling, then filling the inside of the auger with water and measuring the rate of water drop over time. This process was repeated multiple times until subsequent readings were the same. The results of this test indicate that the clay soil at this location has an infiltration rate of approximately 25 minutes per inch. This rate could increase (become slower) over time due to siltation, thus we recommend an appropriate factor of safety be applied for design.

3.0 LABORATORY TESTING

Selected samples of the subsurface soils were subjected to various laboratory tests to assess the following pertinent engineering properties:

1. Moisture Content, ASTM D-2216, Percent moisture representative of field conditions
2. Dry Density, ASTM D-2937, Dry unit weight representing field conditions
3. Atterberg Limits, ASTM D-4318, Plasticity and workability
4. Gradation Analysis, ASTM D-1140/C-117, Grain Size Analysis
5. One Dimension Consolidation, ASTM D-2435, Consolidation properties
6. Laboratory Vane Shear Test, ASTM D-3080, Shear strength parameters
7. Moisture-Density Relationship (Proctor) Test, ASTM D-1557, Compaction properties
8. California Bearing Ratio, ASTM D-2937, Subgrade support properties for pavements

To provide data for an analysis of potential settlement from structural loading, a one-dimensional consolidation test was performed on each of 3 samples of the subsurface soils collected in the bore holes. Based upon data obtained from the consolidation testing, the silt/clay soils at this site are moderately over-consolidated and moderately compressible under additional loading. Detailed results of the consolidation tests are maintained within our files and can be transmitted to you, if so desired.

Laboratory test results are presented on the bore hole logs (***Figures 2 through 9***) and in the **Lab Summary Table** on the following page:

LAB SUMMARY TABLE

BORE HOLE	DEPTH (feet)	SOIL CLASS	SAMPLE TYPE	MOISTURE CONTENT(%)	DRY DENSITY (pcf)	GRADATION			ATTERBERG LIMITS			VANE SHEAR (psf)
						GRAV.	SAND	FINES	LL	PL	PI	
B-1	2.5	CL	Shelby	21	97				36	21	15	
B-1	10	CL	Rings	32	91			91				
B-1	20	CL	Shelby	31	93	0	19	81	28	20	8	89
B-1	30	SP-SM	SPT	12		31	58	11				
B-1	40	SM	SPT	18		12	56	32		NP		
B-1	45	GP	SPT	21	111							501
B-1	50	SP-SM	SPT	10		38	56	6				
B-2	7.5	CL	Rings	28	94			90				
B-2	15	CL	Rings	30	85							
B-3	2.5	CL	Rings	16	110							
B-3	5	CL	Shelby	16	115							
B-3	7.5	SM	SPT	25	105	0	69	31				
B-4	7.5	CL	Rings	16	107							
B-4	15	CL	Rings	29	95							1591
B-4	20	CL	SPT	29					30	17	13	
B-4	25	SM	SPT	16		29	53	18				
B-7	5	CL	SPT	7		29	55	16				

4.0 GEOLOGIC & SEISMIC CONDITIONS

4.1 Geologic Setting

The subject site is in the east-central portion of Davis County in north-central Utah and sits at an elevation of approximately 4,272 feet above sea level in a valley bound by the Wasatch Mountains on the east and Antelope Island (Great Salt Lake) and the Promontory Mountains to the west. The valley is a deep, sediment-filled basin that is part of the Basin and Range Physiographic Province. The valley was formed by extensional tectonic processes during the Tertiary and Quaternary geologic time periods. The valley is located within the Intermountain Seismic Belt, a zone of ongoing tectonism and seismic activity extending from southwestern Montana to southwestern Utah. The active (evidence of movement in the last 10,000 years) Wasatch Fault Zone is part of the Intermountain Seismic Belt and extends from southeastern Idaho to central Utah along the western base of the Wasatch Mountain Range.

Much of northwestern Utah, including the valley in which the subject site is located, was also previously covered by the Pleistocene age Lake Bonneville. The Great Salt Lake, located along the western margin of the valley and beyond, is a remnant of this ancient freshwater lake. Lake Bonneville reached a high-stand elevation of between approximately 5,160 and 5,200 feet above sea level at between 18,500 and 17,400 years ago. Approximately 17,400 years ago, the lake breached its basin in southeastern Idaho and dropped by almost 300 feet relatively fast as water drained into the Snake River. Following this catastrophic release, the lake level continued to drop slowly over time, primarily driven by drier climatic conditions, until reaching the current level of the Great Salt Lake. Shoreline terraces formed at the high-stand elevation of the lake and several subsequent lower lake levels

are visible in places on the mountain slopes surrounding the valley. Much of the sediment within the valley was deposited as lacustrine sediments during both the transgressive (rise) and regressive (fall) phases of Lake Bonneville and in older, pre-Bonneville lakes that previously occupied the basin.

The geology of the USGS Farmington, Utah 7.5 Minute Quadrangle, that includes the location of the subject site, has been mapped by Lowe and others[2]. The surficial geology of the southeastern portion of the site is mapped as "Younger alluvial-fan deposits" (Map Unit Qaf_1) dated upper Holocene. Unit Qaf_1 is described in the referenced map as "Mixture of gravel and sand deposited by streams, and diamicton deposited by debris flows; forms fans, locally with distinct levees and channels, at mouths of mountain-front canyons; exposed thickness less than 6 meters (20 ft)." The northwestern portion of the site is mapped as "Fill and disturbed land (historical)" (Map Unit Qfd). Unit Qfd is described as "Land disturbed and excavated through aggregate (sand and gravel) operations and construction of Interstate highways, highway interchanges, and Farmington Bay dikes." Refer to **Exhibit 2 - Geologic Map**, shown below:

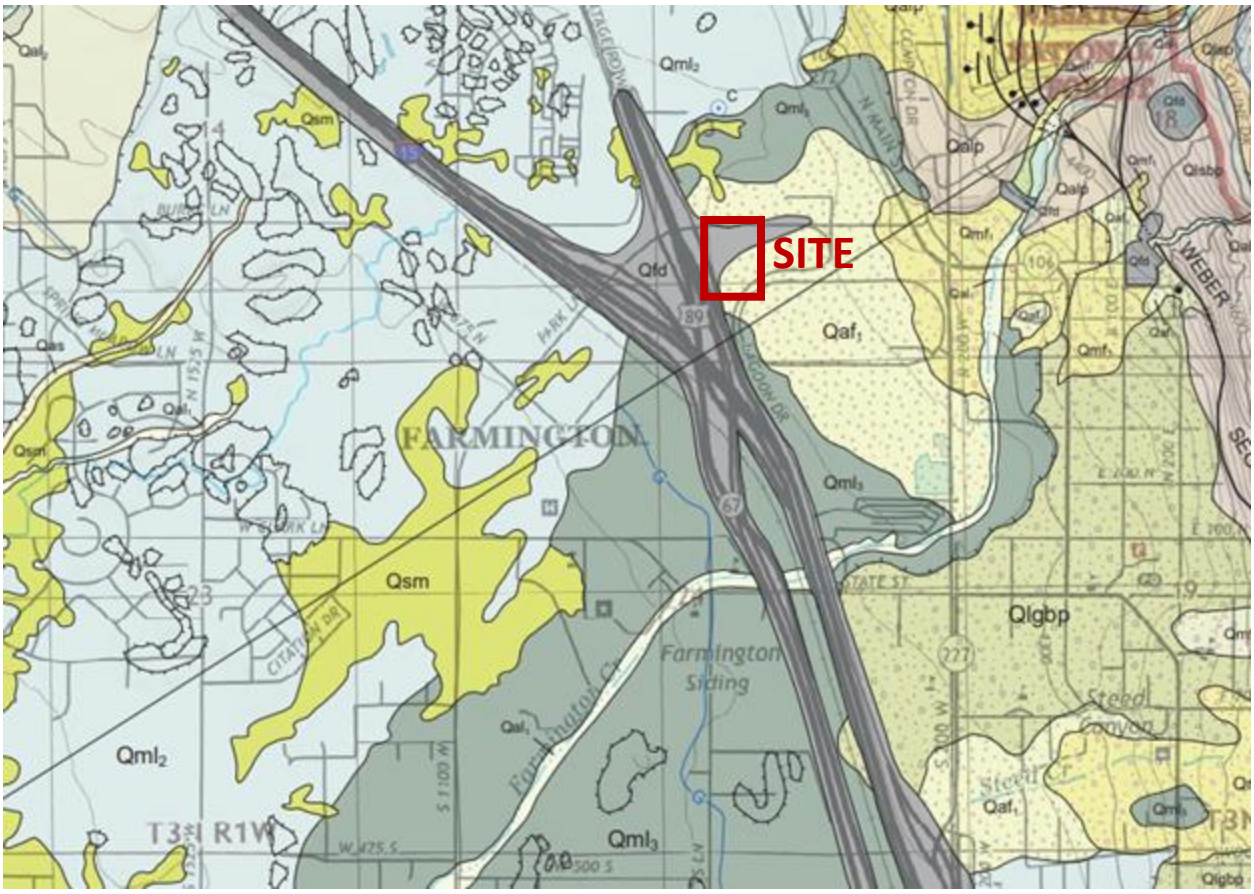


EXHIBIT 2 - GEOLOGIC MAP

[2]Lowe, M., Kirby, S.M., and Harty, K.M., 2018, Geologic Map of the Farmington Quadrangle, Salt Lake and Davis Counties, Utah; Utah Geological Survey Map 279 DM, Scale 1:24,000.

4.2 Faulting

No surface fault traces are shown on the referenced geologic map crossing, adjacent to, or projecting toward the subject site. The nearest mapped active (Holocene) fault is the Weber Segment of the Wasatch Fault Zone approximately 0.5 miles to the northeast.

4.3 Seismicity

4.3.1 Site Class

Utah has adopted the International Building Code (IBC) 2021, which determines the seismic hazard for a site based upon 2014 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points). For site class definitions, IBC 2021 Section 1613.2.2 refers to Chapter 20, *Site Classification Procedure for Seismic Design*, of ASCE[3] 7, which stipulates that the weighted average values of shear wave velocity, blow count and/or shear strength within the upper 100 feet (30 meters) be utilized to determine seismic site class.

Based on average shear wave velocity data within the upper 30 meters ($V_{S,30}$) published by McDonald and Ashland[4], the subject site is located within unit description Q02D, which has a log-mean $V_{S,30}$ of 271 meters per second (889 feet per second). Thus, it is our opinion the site best fits Site Class D – Stiff Soil (with data), which we recommend for seismic structural design.

4.3.2 Ground Motions

A site-specific ground motion hazard analysis study will be completed for the site and provided in a separate report.

4.3.3 Liquefaction

Liquefaction is defined as the condition when saturated, loose, sandy soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event. Clayey soils, even if saturated, will generally not liquefy during a major seismic event.

The site is located within areas designated by the Utah Geologic Survey[5] having both “Moderate” and “High” liquefaction potential. Moderate potential is defined as having between a 10% and 50% probability that within a 100-year period an earthquake strong enough to cause liquefaction will occur. High potential is defined as having a 50% probability.

[3] American Society of Civil Engineers
[4] McDonald, G.N. and Ashland, F.X., 2008, “Earthquake Site-Conditions Map for the Wasatch Front Urban Corridor, Utah,” Utah Geological Survey Special Study 125, 41 pp.
[5] Utah Geological Survey, "Liquefaction-Potential Map for a Part of Davis County, Utah," Utah Geological Survey Public Information Series 24, August 1994. https://ugspub.nr.utah.gov/publications/public_information/pi-24.pdf

Subsurface soils encountered consisted predominately of clay, but layers of saturated sand were encountered in each of the bore holes where groundwater was encountered (B-1, B-3, B-4). We evaluated the liquefaction potential of these saturated sand layers using the procedures described in Youd et al[6] and Idriss & Boulanger[7]. Our evaluation indicates the layers at about 40 feet and 45 feet in B-1, the layer in B-3 at about 10 feet, and the layer in B-4 at about 25 feet, could liquefy in a large enough seismic event. Maximum anticipated settlement resulting from the liquefaction is in the range of 1.0 to 1.5 inches at the top of the liquefiable soil layers. However, using the boundary curves provided by Ishihara[8] for identifying when liquefaction-induced damage would occur at the surface, it is our opinion that less than 1 inch of liquefaction-induced settlement will occur within 3 feet of the ground surface. This amount of settlement is considered tolerable for structures, although relatively minor structural damage would be possible. Lateral spreading due to liquefaction is not anticipated to occur. If such liquefaction-induced settlements are not acceptable, we can provide mitigation strategies, such as aggregate columns or other soil densification methods, to treat susceptible soils.

4.4 Other Geologic Hazards

The site is not located within a known or mapped landslide, debris flow, stream flooding[9], or rock fall hazard area.

5.0 SITE CONDITIONS

5.1 Surface Conditions

At the time the bore holes were drilled, the site was vacant and vegetated with grasses, weeds, and a line of trees through the central portion of the site. Overall, the site is relatively flat, with a very slight slope downward to the west. Based upon aerial photos dating back to 1993 that are readily available on the internet, the site appears to have remained relatively unchanged. The aerial photos also indicate the portion for the site south of the line of trees has generally remained more verdant than the area to the north of the line of trees. The site is bordered on the north by 675 North Street, on the south by Lagoon Drive, on the east by a State Liquor Store, and on the west by Highway 89 northbound off-ramp (see **Vicinity Map** in **Section 1.1** above).

[6] Youd, T.L.; Idriss, I.M.; Andrus, R.D.; Arango, I.; Castro, G.; Christian, J.T.; Dobry, R.; Finn, W.D.L.; Harder, L.F. Jr.; Hynes, M.E.; Ishihara, K.; Koester, J.P.; Liao, S.C.; Marcuson, W.F. III; Martin, G.R.; Mitchell, J.K.; Moriwaki, Y.; Power, M.S.; Robertson, P.K.; Seed, R.B.; and Stokoe, K.H. II; October 2001, "Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils," ASCE Journal of Geotechnical and Geoenvironmental Engineering, p 817-833.

[7] Idriss, I.M. and Boulanger, R.W., December 2010, "SPT-Based Liquefaction Triggering Procedures," Department of Civil & Environmental Engineering, University of California at Davis, Report No. UCD/CGM 10/02, 259 p.

[8] Ishihara, K., 1985, Stability of Natural Deposits During Earthquakes, International Society for Soil Mechanics and Geotechnical Engineering, pp 321-376.

[9] https://msc.fema.gov/portal/search?AddressQuery=500N%20Lagoon%20Dr%2C%20Farmington%2C%20UT%2C%2084025%2C%20USA

5.2 Subsurface Soils

Our field personnel noted topsoil on the surface of varying depth. Based upon the near surface samples of the subsurface soils collected, roots and possibly thin organic layers are present up to about 5 feet in depth, possibly deeper in some areas.

Natural soils encountered beneath the topsoil consisted of CLAY (CL) and SILT (ML) layers which extended to the bottom of bore holes B-5, B-6, and B-8 at about 6.5 feet below the ground surface, to about 5.5 feet below the surface in B-7, to the bottom of B-2 at about 16.5 feet below the surface, to about 24 feet in B-4, and to about 25 feet below the surface in B-1. The silt/clay soils were moist to wet, brown to black in color, and very soft to medium stiff in consistency. They also exhibited moderate over-consolidation and strength characteristics with moderate compressibility characteristics.

Below the clay and silt layers, we encountered layers of Silty SAND (SM) and Poorly Graded SAND with silt (SP-SM), and an occasional layer of Poorly Graded GRAVEL (GP) with sand, extending to the bottom of bore holes B-3, B-4, and B-7 at approximately 11.5 feet, 31.5 feet, and 6.5 feet below existing site grades, respectively. Some thinner layers of clay were encountered interbedded with the sands near the bottom of B-1 before terminating in SAND at about 51.5 feet below existing site grades. The natural sand and gravel soils were moist to wet, tan to blue gray in color, and loose to dense based on the blow counts in the bore holes.

For a more descriptive interpretation of subsurface conditions, please refer to the bore hole logs, ***Figures 2 through 9***, which graphically represent the subsurface conditions encountered. The lines designating the interface between soil types on the logs generally represent approximate boundaries; in situ, the transition between soil types may be gradual.

5.3 Groundwater

Groundwater was encountered in bore hole B-1 at about 17 feet below the ground surface, in B-3 at about 9.5 feet below the ground surface, and in B-4 at about 24 feet below the ground surface. On June 11, 2024, CMT personnel returned to the site and measured groundwater level at a depth of about 5.6 feet within slotted PVC pipes installed in bore hole B-3. This depth to groundwater will affect excavations.

Groundwater levels can fluctuate seasonally. Numerous other factors such as heavy precipitation, irrigation of neighboring land, and other unforeseen factors, may also influence ground water elevations at the site. The detailed evaluation of these and other factors, which may be responsible for ground water fluctuations, and the magnitude of potential fluctuations, is beyond the scope of this study.

5.4 Site Subsurface Variations

Based on the results of the subsurface explorations and our experience, variations in the continuity and nature of subsurface conditions should be anticipated. Due to the heterogeneous characteristics of natural soils, care should be taken in interpolating or extrapolating subsurface conditions between or beyond the exploratory locations.

6.0 SITE PREPARATION AND GRADING

6.1 General

All deleterious materials should be stripped from the site prior to commencement of construction activities. This includes vegetation, topsoil, loose and disturbed soils, etc. Based upon the conditions observed in the bore holes there is topsoil on the surface of the site with roots potentially extending up to 5 feet in depth in some places. Thin organic layers may also be encountered within the upper 5 feet. When stripping and grubbing, topsoil should be distinguished by the apparent organic content and not solely by color.

Following clearing and grubbing the subgrade should be observed by a CMT geotechnical engineer to assess that suitable natural soils have been exposed and any deleterious materials, loose and/or disturbed soils have been removed, prior to placing site grading fills, footings, slabs, and pavements.

Fill placed over large areas to raise overall site grades can induce settlements in the underlying natural soils. If more than 3 feet of site grading fill is anticipated over the natural ground surface, we should be notified to assess potential settlements and provide additional recommendations as needed. These recommendations may include placement of the site grading fill far in advance to allow potential settlements to occur prior to construction.

6.2 Temporary Excavations

Excavations deeper than 8 feet are not anticipated at the site. The shallowest groundwater was encountered in bore hole B-3 at about 9.5 feet below the ground surface. Deeper excavations could potentially encounter groundwater. The past aerial photos of the site indicate the portion of the site south of the tree line seems to stay greener throughout the year, possibly indicating more moist conditions in this area.

The natural soils encountered at this site predominantly consisted of silt/clay. In clayey (cohesive) soils, temporary construction excavations not exceeding 4 feet in depth may be constructed with near-vertical side slopes. Temporary excavations up to 8 feet deep, above or below groundwater, may be constructed with side slopes no steeper than one-half horizontal to one vertical (0.5H:1V).

For sandy/gravelly (cohesionless) soils, temporary construction excavations not exceeding 4 feet in depth should be no steeper than one-half horizontal to one vertical (0.5H:1V). For excavations up to 8 feet and above groundwater, side slopes should be no steeper than one horizontal to one vertical (1H:1V). Excavations encountering saturated cohesionless soils will be very difficult to maintain and will require very flat side slopes and/or shoring, bracing and dewatering.

To reduce disturbance of the natural soils during excavation, we recommend that smooth edge buckets/blades be utilized.

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated. All excavations should be made following OSHA safety guidelines.

6.3 Fill Material

Structural fill is defined as fill that will ultimately be subjected to structural loads imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and potentially as replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials. Following are our recommendations for the various fill types we anticipate will be used at this site:

FILL MATERIAL TYPE	DESCRIPTION | RECOMMENDED SPECIFICATION
Structural Fill	Placed below structures, flatwork and pavement. Well-graded sand/gravel mixture, with maximum particle size of 4 inches, a minimum 70% passing 3/4-inch sieve, approximately 30% to 70% passing the No. 4 sieve, a maximum 20% passing the No. 200 sieve, and a maximum Plasticity Index of 10.
Site Grading Fill	Placed over large areas to raise the site grade. Sandy to gravelly soil, with a maximum particle size of 6 inches, a minimum 70% passing 3/4-inch sieve, a maximum 50% passing No. 200 sieve, and a maximum Plasticity Index of 15.
Non-Structural Fill	Placed below non-structural areas, such as landscaping. On-site soils or imported soils, with a maximum particle size of 8 inches, including silt/clay soils not containing excessive amounts of degradable/organic material (see discussion below).
Stabilization Fill	Placed to stabilize soft areas prior to placing structural fill and/or site grading fill. Coarse angular gravels and cobbles 1 inch to 8 inches in size. May also use 1.5- to 2.0-inch gravel placed on stabilization fabric, such as Mirafi RS280i, or equivalent (see **Section 6.6**).

On-site silt/clay soils are not suitable for use as structural fill or as site grading fill, but can be used as non-structural fill.

All fill material should be approved by a CMT geotechnical engineer prior to placement.

6.4 Fill Placement and Compaction

The various types of compaction equipment available have their limitations as to the maximum lift thickness that can be compacted. For example, hand operated equipment is limited to lifts of about 4 inches and most "trench compactors" have a maximum, consistent compaction depth of about 6 inches. Large rollers, depending on soil and moisture conditions, can achieve compaction at 8 to 12 inches. The full thickness of each lift should be compacted to at least the following percentages of the maximum dry density as determined by ASTM D-1557 (or AASHTO[10] T-180) in accordance with the following recommendations:

[10] American Association of State Highway and Transportation Officials

LOCATION	TOTAL FILL THICKNESS (FEET)	MINIMUM PERCENTAGE OF MAXIMUM DRY DENSITY
Beneath an area extending at least 4 feet beyond the perimeter of structures, and below flatwork and pavement (applies to structural fill and site grading fill) extending at least 2 feet beyond the perimeter	0 to 5 5 to 8	95 98
Site grading fill outside area defined above	0 to 5 5 to 8	92 95
Utility trenches within structural areas	--	96
Roadbase and subbase	-	96
Non-structural fill	0 to 5 5 to 8	90 92

Structural fills greater than 5 feet thick are not anticipated at the site. For best compaction results, we recommend that the moisture content for structural fill/backfill be within 2% of optimum. Field density tests should be performed on each lift as necessary to verify that proper compaction is being achieved.

6.5 Utility Trenches

For the bedding zone around the utility, we recommend utilizing sand bedding fill material that meets current APWA[11] requirements. All utility trench backfill material below structurally loaded facilities (foundations, floor slabs, flatwork, parking lots/drive areas, etc.) should be placed at the same density requirements established for structural fill in the previous section.

Most utility companies and local governments are requiring Type A-1a or A-1b (AASHTO Designation) soils (sand/gravel soils with limited fines) be used as backfill over utilities within public rights of way, and the backfill be compacted over the full depth above the bedding zone to at least 96% of the maximum dry density as determined by AASHTO T-180 (ASTM D-1557).

Where the utility does not underlie structurally loaded facilities and public rights of way, natural soils (if free of organics) may be utilized as trench backfill above the bedding layer, provided they are properly moisture conditioned and compacted to the minimum requirements stated above in **Section 6.4**.

6.6 Stabilization

The natural silt/clay soils at this site will likely be susceptible to rutting and pumping. The likelihood of disturbance or rutting and/or pumping of the existing natural soils is a function of the moisture content, the load applied to the surface, as well as the frequency of the load. Consequently, rutting and pumping can be reduced by avoiding concentrated traffic, reducing the load applied to the surface by using lighter equipment and/or partial loads, by working in drier times of the year, or by providing a working surface for the equipment. Rubber-tired equipment particularly, because of high pressures, promotes instability in moist/wet, soft soils.

[11] American Public Works Association

If rutting or pumping occurs, traffic should be stopped, and the disturbed soils should be removed and replaced with stabilization material. Typically, a minimum of 18 inches of the disturbed soils must be removed to be effective. However, deeper removal is sometimes required.

To stabilize soft subgrade conditions (if encountered), a mixture of coarse, clean, angular gravels and cobbles and/or 1.5- to 2.0-inch clean gravel should be utilized. This coarse material may be placed and worked into the soft soils until firm and non-yielding or the soft soils removed an additional, minimum of 18 inches, and backfilled with the clean stabilizing fill. A test area should be implemented to achieve a proper stabilization strategy. Often the amount of gravelly material can be reduced with the use of a geotextile fabric such as Mirafi RS280i, or equivalent. Its use will also help avoid mixing of the subgrade soils with the gravelly material. After excavating the soft/disturbed soils, the fabric should be spread across the bottom of the excavation and up the sides a minimum of 18 inches. Otherwise, it should be placed in accordance with the manufacturer's recommendation, including proper overlaps. The gravel material can then be placed over the fabric in compacted lifts as described above.

7.0 FOUNDATION RECOMMENDATIONS

The following recommendations have been developed based on the previously described project characteristics, the subsurface conditions observed in the field and the laboratory test data, as well as common geotechnical engineering practice.

7.1 Continuous/Spread Footings

Based on our geotechnical engineering analyses, the proposed structure may be supported upon conventional spread and/or continuous wall foundations placed on suitable, undisturbed natural soils and/or on structural fill extending to suitable natural soils. Footings may be designed using a net bearing pressure of 2,000 psf if placed on suitable, undisturbed, natural soils or 2,500 psf if placed on a minimum 18 inches of structural fill.

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade, thus the weight of the footing and backfill to lowest adjacent final grade need not be considered. The allowable bearing pressure may be increased by ½ for temporary loads such as wind and seismic forces.

We also recommend the following:

1. Exterior footings subject to frost should be placed at least 30 inches below final grade.
2. Interior footings not subject to frost should be placed at least 16 inches below grade.
3. Continuous footing widths should be maintained at a minimum of 18 inches.
4. Isolated footings should be a minimum of 24 inches wide.

7.2 Installation

Under no circumstances shall foundations be placed on undocumented fill, topsoil with organics, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. Deep, large roots may be encountered where trees and larger bushes are located or were previously located at the site; such large roots should be removed. If these or other unsuitable soils are encountered, they must be completely removed and replaced with properly compacted structural fill.

The base of footing excavations should be observed by a CMT geotechnical engineer to assess if suitable bearing soils have been exposed.

All structural fill placed immediately below footings should meet the requirements for such and should be placed and compacted in accordance with **Section 6** above. The width of structural replacement fill below footings should be equal to the width of the footing plus 1 foot for each foot of fill thickness. For instance, if the footing width is 2 feet and the structural fill depth beneath the footing is 2 feet, the fill replacement width should be 4 feet, centered beneath the footing.

The minimum thickness of structural fill below footings should be equivalent to one-third the thickness of structural fill below any other portion of the foundations. For example, if the maximum depth of structural fill is 6 feet, all footings for the new structure should be underlain by a minimum 2 feet of structural fill.

7.3 Estimated Settlement

Foundations designed and constructed in accordance with our recommendations could experience settlement, but we anticipate that total settlements of footings founded as recommended above will not exceed 1 inch, with differential settlements on the order of 0.5 inches over a distance of 25 feet. We expect approximately 50% of the total settlement to initially take place during construction.

7.4 Lateral Resistance

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.30 for natural silt/clay soils or 0.40 for structural fill, may be utilized for design. Passive resistance provided by properly placed and compacted natural, unsaturated clay/silt soils may be considered equivalent to a fluid with a density of 350 pcf. A combination of passive earth resistance and friction may be utilized if the passive resistance component of the total is divided by 1.5. Note that frictional resistance is mobilized as soon as any movement occurs, while full passive pressure is typically achieved after a small amount of movement occurs (approximately 0.5% of the footing height).

8.0 LATERAL EARTH PRESSURES

We anticipate that below-grade walls up to 4 feet high might be constructed at this site. The lateral earth pressure values given below are for a backfill material that will consist of drained natural clay/silt soils placed and compacted in accordance with the recommendations presented herein. If other soil types will be used as backfill, we should be notified so that appropriate modifications to these values can be provided, as needed.

The lateral pressures imposed upon subgrade facilities will depend upon the relative rigidity and movement of the backfilled structure. Following are the recommended lateral pressure values, which also assume that the soil surface behind the wall is horizontal and that the backfill within 3 feet of the wall will be compacted with hand-operated compacting equipment. Subgrade walls less than 12 feet high do not require incorporating a seismic at-rest lateral earth pressure for design.

CONDITION	STATIC (psf/ft)*	SEISMIC (psf/ft)**
Active Pressure (wall is allowed to yield, i.e. move away from the soil, with a minimum 0.001H movement/rotation at the top of the wall, where "H" is the total height of the wall)	40	38
At-Rest Pressure (wall is not allowed to yield)	60	N/A
Passive Pressure (wall moves into the soil)	350	180

*Equivalent Fluid Pressure (applied at 1/3 Height of Wall)

**Equivalent Fluid Pressure (added to static and applied at 1/3 Height of Wall)

9.0 FLOOR SLABS

Properly engineered floor slabs should be established upon uniform, compacted bearing soils comprised of suitable, undisturbed, uniform natural soils and/or on structural fill extending to suitable natural soils (same as for foundations). Under no circumstances shall floor slabs be established directly on any topsoil, undocumented fills, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. Floor slabs should be properly designed by a structural engineer to accommodate anticipated loads.

To facilitate curing of the concrete, we recommend that floor slabs be directly underlain by at least 4 inches of moist aggregate base or bedding material, or "free-draining" fill such as "pea" gravel or 1-inch minus, clean, gap-graded gravel. To help control normal shrinkage and stress cracking, the floor slab thickness and joint layout should be designed by a qualified structural engineer. Design provisions should address the following features:

1. Adequate reinforcement for the anticipated floor loads;
2. Using smooth bar reinforcement for load transfer through interior floor joints;
3. Portland cement concrete mix design selection to minimize shrinkage concerns;
4. Joint layout and spacing in accordance with ACI[12] or other local standards recommendations; and
5. Properly isolate floor slabs from foundations and other structural elements per recommendations provided by ACI 302 (Guide to Concrete Floor and Slab Construction).

10.0 DRAINAGE RECOMMENDATIONS

It is important to the long-term performance of foundations and floor slabs that water is not allowed to collect near the foundation walls and infiltrate into the underlying soils. We recommend the following:

1. All areas around the structure should be sloped to provide drainage away from the foundations. We recommend a minimum slope of 4 inches in the first 10 feet away from the structure. This slope should be maintained throughout the lifetime of the structure.

2. All roof drainage should be collected in rain gutters with downspouts designed to discharge at least 10 feet from the foundation walls or well beyond the backfill limits, whichever is greater.

3. Adequate compaction of the foundation backfill should be provided. We suggest a minimum of 90% of the maximum laboratory density as determined by ASTM D-1557. Water consolidation methods should not be used under any circumstances.

4. Landscape sprinklers should be aimed away from the foundation walls. The sprinkling systems should be designed with proper drainage and be well-maintained. Overwatering should be avoided.

5. Other precautions that may become evident during construction.

11.0 PAVEMENTS

All pavement areas must be prepared as discussed above in **Section 6.1**. Under no circumstances shall pavements be established over topsoil, undocumented fills (if encountered), loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In pavement areas, subsequent to stripping and prior to the placement of pavement materials, the exposed subgrade must be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If soft, pumping, or otherwise unsuitable soils are encountered, we recommend they be removed to a minimum of 18 inches below the subgrade level and replaced with structural fill.

We anticipate the natural silt/clay soils will exhibit poor pavement support characteristics when saturated or nearly saturated. To provide data to aid in pavement design a California Bearing Ratio (CBR) test was performed

[12] American Concrete Institute

on a bulk sample of the near surface soils conglomerated from the cuttings from several of the bore holes. Results are presented in the following table:

SAMPLE TYPE	SOIL CLASS	OPTIMUM MOISTURE(%)	MAX DRY DENSITY (pcf)	CBR (%)
Bulk	CL	11.3	119.1	4

DCP testing was also utilized to assess the subgrade soils for pavement support. Results showed considerable variation with correlated CBR values ranging from a low of about 2 to a high of about 90 between depths of about 10 inches and 30 inches below the surface.

We have used the laboratory determined CBR value of 4 as the basis for pavement design. Given the projected traffic as discussed above in **Section 1.3**, the following pavement sections are recommended for the given ESAL's (18-kip equivalent single-axle loads) per day:

MATERIAL	PAVEMENT SECTION THICKNESS (inches)			
	PARKING AREAS (1 ESAL per day)		DRIVE AREAS (3 ESAL'S per day)	
Asphalt	**3**	**3**	**3.5**	**3.5**
Road-Base (UTBC)	**8**	**4**	**10**	**6**
Subbase	**0**	**6**	**0**	**6**
Total Thickness	**11**	**13**	**13.5**	**15.5**

Untreated base course (UTBC), typically known as road-base, should conform to city specifications, or to 1-inch-minus UDOT specifications for A–1-a/NP, and have a minimum CBR value of 70%. Material meeting our specification for structural fill can be used for subbase, as long as the fines content (percent passing No. 200 sieve) does not exceed 15%. Roadbase and subbase material should be compacted as recommended above in **Section 6.4**. Asphalt material generally should conform to APWA requirements, having a ½-inch maximum aggregate size, a 75-gyration Superpave mix containing no more than 15% of recycled asphalt (RAP) and a PG58-28 binder.

For dumpster pads, we recommend a pavement section consisting of 6.5 inches of Portland cement concrete and 6 inches of aggregate base over properly prepared suitable natural subgrade or site grading structural fills extending to suitable natural soils. Dumpster pads constructed overlying undocumented fills (if encountered) must be avoided or heavily reinforced.

12.0 QUALITY CONTROL

We recommend that CMT be retained as part of a comprehensive quality control testing and observation program. With CMT onsite we can help facilitate implementation of our recommendations and address, in a timely manner, any subsurface conditions encountered which vary from those described in this report. Without such a program CMT cannot be responsible for application of our recommendations to subsurface conditions which may vary from those described herein. This program may include, but not necessarily be limited to, the following:

12.1 Field Observations

Observations should be completed during all phases of construction such as site preparation, foundation excavation, structural fill placement and concrete placement.

12.2 Fill Compaction

Compaction testing by CMT is required for all structural supporting fill materials. Maximum Dry Density (Modified Proctor, ASTM D-1557) tests should be requested by the contractor immediately after delivery of any fill materials. The maximum density information should then be used for field density tests on each lift as necessary to verify that the required compaction is being achieved.

12.3 Excavations

All excavation procedures and processes should be observed by a geotechnical engineer from CMT or his representative. In addition, for the recommendations in this report to be valid, all backfill and structural fill placed in trenches and all pavements should be density tested by CMT. We recommend that freshly mixed concrete be tested by CMT in accordance with ASTM designations.

13.0 LIMITATIONS

The recommendations provided herein were developed by evaluating the information obtained from the subsurface explorations and soils encountered therein. The exploration logs reflect the subsurface conditions only at the specific location at the particular time designated on the logs. Soil and ground water conditions may differ from conditions encountered at the actual exploration locations. The nature and extent of any variation in the explorations may not become evident until during the course of construction. If variations do appear, it may become necessary to re-evaluate the recommendations of this report after we have observed the variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at 801-590-0394. To schedule materials testing, please call 801-381-5141.

APPENDIX

SUPPORTING
DOCUMENTATION



CMT TECHNICAL SERVICES	**Farmington Regional Center** About 500 North Lagoon Drive, Farmington, Utah	**SITE MAP**	Date: 17-May-1918 CMT No.: 22203	Figure: 1

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-1

Total Depth: 51.5'
Water Depth: 17'
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown to Brown CLAY (CL) with sand, roots, organics, and mica fragments, moist — medium stiff		1	4 4 2	6								
		grades some gravel		2			21	97				36	21	15
4				3	4 4 2	6								
		grades with oxidation												
		grades gray brown with oxidation and roots		4										
8														
		soft		5	4 3 2	5	32	91			91			
12														
				6										
16		wet												
				7			31	93	0	19	81	28	20	8
20														
24		Blue Gray Poorly Graded SAND with silt (SP-SM) and gravel, wet — medium dense		8	7 9 15	24								
28														

Remarks: Groundwater encountered during drilling at depth of 17 feet.

Coordinates: 40.9904574°, -111.9002282°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 2

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-1

Total Depth: 51.5'
Water Depth: 17'

Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N) Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
28		Blue Gray Poorly Graded SAND with silt (SP-SM) and gravel, wet											
		medium dense		9	10 12 15	27	12		31	58	11			
32													
		grades brown to black — medium dense to dense		10	9 12 18	30							
36		Brown Silty SAND (SM) with gravel, wet											
40		grades gray to black — medium dense		11	15 12 5	17	18		12	56	32	NP	NP
		Brown Sandy SILT (ML) with gravel, wet — medium stiff											
44													
		Gray Brown Sandy GRAVEL (GP), wet — loose		12	3 7 9	16	21	111					
48		Gray Brown Sandy CLAY (CL) with oxidation											
		Tan to Gray Brown Poorly Graded SAND with silt (SP-SM) and gravel, oxidation, wet — dense		13	6 12 27	39	10		38	56	6		
52		END AT 51.5'											
56													

Remarks: Groundwater encountered during drilling at depth of 17 feet.

Coordinates: 40.9904574°, -111.9002282°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 2

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-2

Total Depth: 16.5'
Water Depth: 5.6'

Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown to Black Clayey SILT (ML), some sand, roots and organics, moist												
		soft		14	2 1 1	2								
4		grades light brown, sandy with oxidation												
				15	2 2 1	3								
		Light Brown CLAY (CL) with mica, trace sand and oxidation												
		soft		16	3 2 4	6	28	94			90			
8		grades with interbedded layers of sand												
		very soft		17	0 0 0	0								
12														
		soft to medium stiff		18	3 3 5	8	30	85						
16		END AT 16.5'												
20														
24														
28														

Remarks: Groundwater encountered during drilling at depth of feet and measured on 6/11/24 at depth of 5.6 feet.

Slotted PVC pipe installed to depth of 16.5 feet to facilitate water level measurements.

Coordinates: 40.9902395°, -111.8997712°

Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"

Excavated By: Direct Push Services

Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 3

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-3

Total Depth: 11.5'
Water Depth: 9.5'
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown to Black Sandy CLAY (CL) with gravel, mica, roots and organics, moist												
		soft		19	3 3 2	5	16	110						
4														
				20			16	115						
8		Brown Silty SAND (SM), moist		21	3 4 4	8	25	105	0	69	31			
		loose												
		wet		22										
12		END AT 11.5'												
16														
20														
24														
28														

Remarks: Groundwater encountered during drilling at depth of 9.5 feet.

Coordinates: 40.9900021°, -111.9003489°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 4

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-4

Total Depth: 31.5'
Water Depth: 21'

Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown to Black Clayey SILT (ML) with sand, gravel, roots and organics, moist												
		soft		23	2 2 1	3								
4		medium stiff		24	4 3 2	5								
		Gray Brown Sandy CLAY (CL), trace gravel, oxidation and organics, moist												
		soft		25	3 5 2	7	16	107						
8		grades brown with interbedded sand and oxidation												
		soft to medium stiff		26	0 0 4	4								
12														
		soft		27	2 2 4	6	29	95						
16														
20		grades less sand												
		medium stiff to stiff		28	3 3 5	8	29					30	17	13
		wet												
24		Gray Brown Silty SAND (SM) with gravel, wet												
		medium dense		29	12 8 6	14	16		29	53	18			
28														

Remarks: Groundwater encountered during drilling at depth of 21 feet.

Coordinates: 40.9907995°, -111.9003818°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 5

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-4

Total Depth: 31.5'
Water Depth: 21'

Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
28		Gray Brown Silty SAND (SM) with gravel, wet												
		grades less silt very dense		30	4 20 33	53								
32		END AT 31.5'												
36														
40														
44														
48														
52														
56														

Remarks: Groundwater encountered during drilling at depth of 21 feet.

Coordinates: 40.9907995°, -111.9003818°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 5

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-5

Total Depth: 6.5'
Water Depth: (see Remarks)
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown CLAY (CL) with sand and gravel, moist												
		soft		31	3 2 1	3								
4														
		soft to medium stiff		32	1 1 3	4								
		END AT 6.5'												
8														
12														
16														
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: 40.9909273°, -111.8996365°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 6

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-6

Total Depth: 6.5'
Water Depth: (see Remarks)
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown CLAY (CL) with sand, roots and organics, moist												
4		medium stiff		33	0 0 5	5								
		grades with gravel and mica soft		34	1 1 2	3								
		grades with peat												
		END AT 6.5'												
8														
12														
16														
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: 40.9901215°, -111.9008451°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 7

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-7

Total Depth: 6.5'
Water Depth: (see Remarks)
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown Sandy SILT (ML), trace gravel, mica, roots and organics												
		soft		35	3 2 1	3								
4														
		Gray Brown Silty SAND (SM) with gravel and organics, moist medium dense		36	6 5 7	12	7		29	55	16			
		END AT 6.5'												
8														
12														
16														
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: 40.9896923°, -111.900537°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 8

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-8

Total Depth: 6.5'
Water Depth: (see Remarks)
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown CLAY (CL) with sand, trace gravel, roots, moist												
		soft		37	3 2 1	3								
4														
		grades trace sand, with mica, oxidation		38	2 1 1	2								
		END AT 6.5'												
8														
12														
16														
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 9

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Key to Symbols

Date: 5/24/24
Job #: 22203

① Depth (ft)	② GRAPHIC LOG	③ Soil Description	④ Sample Type	⑤ Sample #	Blows(N) ⑥	Blows(N) ⑦ Total	⑧ Moisture (%)	⑨ Dry Density(pcf)	Gradation ⑩ Gravel %	Gradation ⑩ Sand %	Gradation ⑩ Fines %	Atterberg ⑪ LL	Atterberg ⑪ PL	Atterberg ⑪ PI

COLUMN DESCRIPTIONS

① **Depth (ft.):** Depth (feet) below the ground surface (including groundwater depth - see below right).

② **Graphic Log:** Graphic depicting type of soil encountered (see ② below).

③ **Soil Description:** Description of soils, including Unified Soil Classification Symbol (see below).

④ **Sample Type:** Type of soil sample collected; sampler symbols are explained below-right.

⑤ **Sample #:** Consecutive numbering of soil samples collected during field exploration.

⑥ **Blows:** Number of blows to advance sampler in 6" increments, using a 140-lb hammer with 30" drop.

⑦ **Total Blows:** Number of blows to advance sampler the 2nd and 3rd 6" increments.

⑧ **Moisture (%):** Water content of soil sample measured in laboratory (percentage of dry weight).

⑨ **Dry Density (pcf):** The dry density of a soil measured in laboratory (pounds per cubic foot).

⑩ **Gradation:** Percentages of Gravel, Sand and Fines (Silt/Clay), from lab test results of soil passing No. 4 and No. 200 sieves.

⑪ **Atterberg:** Individual descriptions of Atterberg Tests are as follows:

LL = Liquid Limit (%): Water content at which a soil changes from plastic to liquid behavior.

PL = Plastic Limit (%): Water content at which a soil changes from liquid to plastic behavior.

PI = Plasticity Index (%): Range of water content at which a soil exhibits plastic properties (= Liquid Limit - Plastic Limit).

STRATIFICATION	
Description	**Thickness**
Seam	Up to ½ inch
Lense	Up to 12 inches
Layer	Greater than 12 in.
Occasional	1 or less per foot
Frequent	More than 1 per foot

MODIFIERS
Trace
<5%
Some
5-12%
With
> 12%

MOISTURE CONTENT
Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp / moist to the touch, but no visible water.
Saturated: Visible water, usually soil below groundwater.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS SYMBOLS	②	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS: More than 50% of material is larger than No. 200 sieve size.	GRAVELS: The coarse fraction retained on No. 4 sieve.	CLEAN GRAVELS (< 5% fines)	GW		Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP		Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (≥ 12% fines)	GM		Silty Gravels, Gravel-Sand-Silt Mixtures
			GC		Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS: The coarse fraction passing through No. 4 sieve.	CLEAN SANDS (< 5% fines)	SW		Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP		Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (≥ 12% fines)	SM		Silty Sands, Sand-Silt Mixtures
			SC		Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS: More than 50% of material is smaller than No. 200 sieve size.	SILTS AND CLAYS: Liquid Limit less than 50%		ML		Inorganic Silts and Very Fine Sands, Silty or Clayey Fine Sands or Clayey Silts with Slight
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean
			OL		Organic Silts and Organic Silty Clays o f Low Plasticity
	SILTS AND CLAYS: Liquid Limit greater than 50%		MH		Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils with Plasticity (Elastic Silts)
			CH		Inorganic Clays of High Plasticity, Fat Clays
			OH		Organic Silts and Organic Clays of Medium to High Plasticity
HIGHLY ORGANIC SOILS			PT		Peat, Humus, Swamp Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications (i.e. GP-GM, SC-SM, etc.).

SAMPLER SYMBOLS

- Block Sample
- Bulk/Bag Sample
- Modified California Sampler 3.5" OD, 2.42" ID
- D&M Sampler
- Rock Core
- Standard Penetration Split Spoon Sampler
- Thin Wall (Shelby Tube)

WATER SYMBOL

- Encountered Water Level
- Measured Water Level

(see Remarks on Logs)

1. The results of laboratory tests on the samples collected are shown on the logs at the respective sample depths.
2. The subsurface conditions represented on the logs are for the locations specified. Caution should be exercised if interpolating between or extrapolating beyond the exploration locations.
3. The information presented on each log is subject to the limitations, conclusions, and recommendations presented in this report.

CMT TECHNICAL SERVICES

Figure: 10

DCP TEST DATA

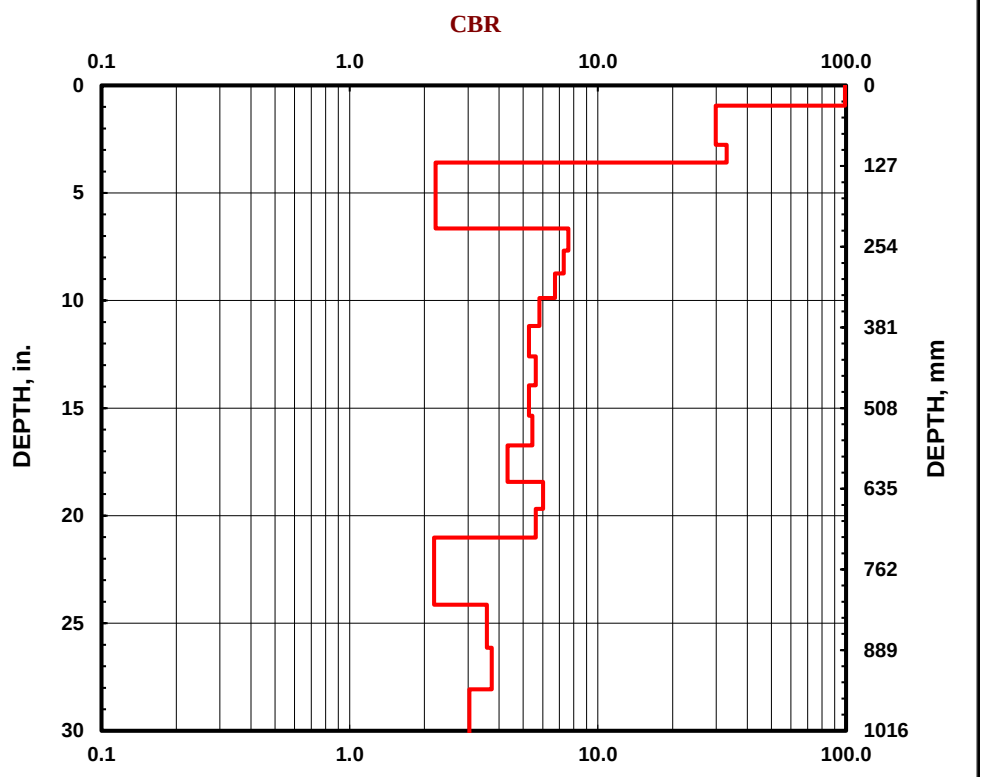
Project: *Farmington Regional Center* **Date:** 24-May-24

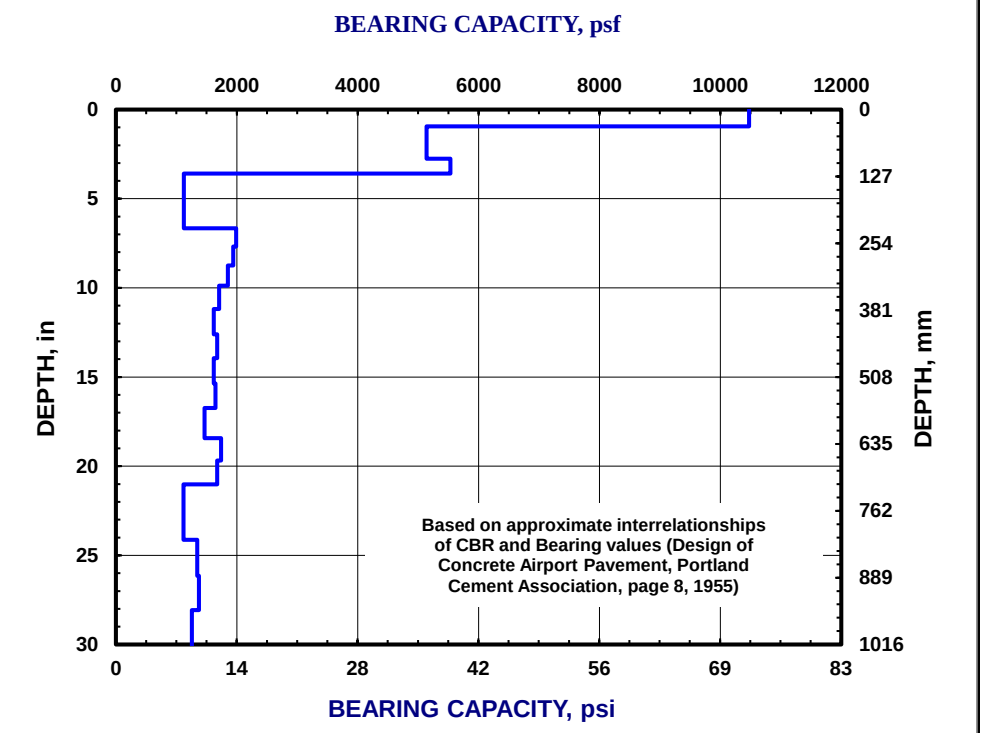
Location: B-2 **Soil Type(s):**

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	2
0	24	1
3	47	1
3	70	1
3	91	1
1	169	1
1	195	1
1	222	1
1	251	1
1	284	1
1	320	1
1	354	1
1	390	1
1	425	1
1	468	1
1	500	1
1	534	1
1	613	1
1	664	1
1	713	1
1	772	1
1	830	1
0	0	1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1





DCP TEST DATA

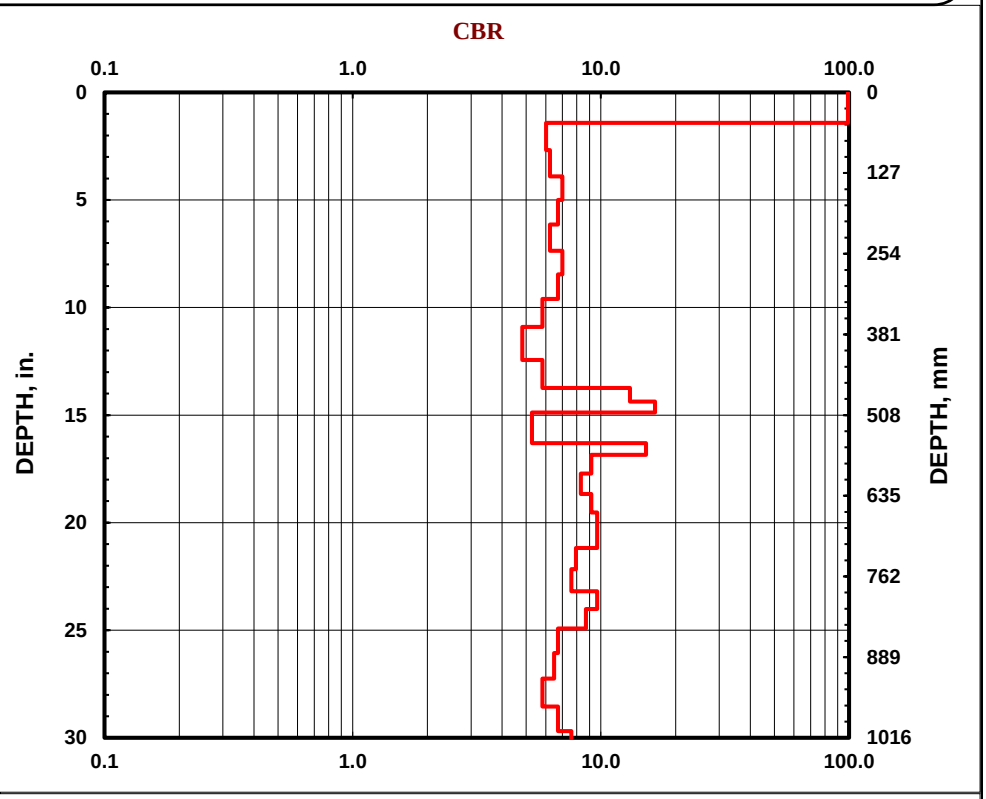
Project: *Farmington Regional Center* **Date:** 24-May-24

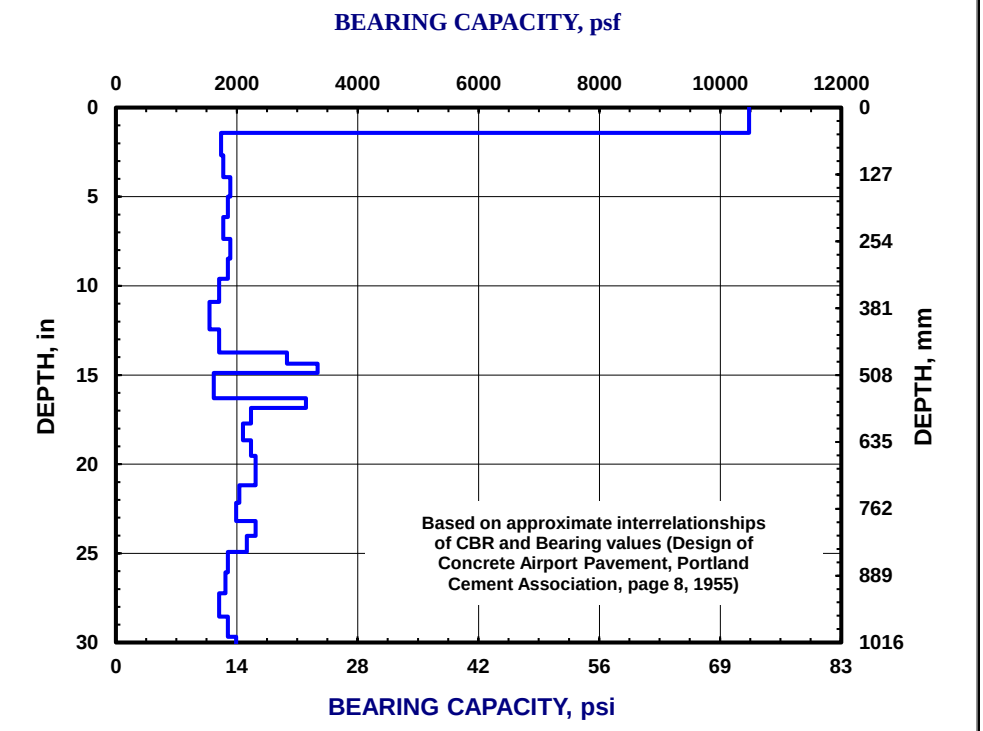
Location: B-3 **Soil Type(s):**

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	2
0	36	1
1	68	1
1	99	1
1	127	1
1	156	1
1	187	1
1	215	1
1	244	1
1	277	1
1	316	1
1	349	1
1	365	1
1	378	1
1	414	1
1	428	1
1	450	1
1	474	1
1	496	1
1	517	1
1	538	1
1	563	1
1	589	1
1	610	1
1	633	1
1	662	1
1	692	1
1	725	1
1	754	1
1	780	1
1	794	1
0	0	1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1
		1





DCP TEST DATA

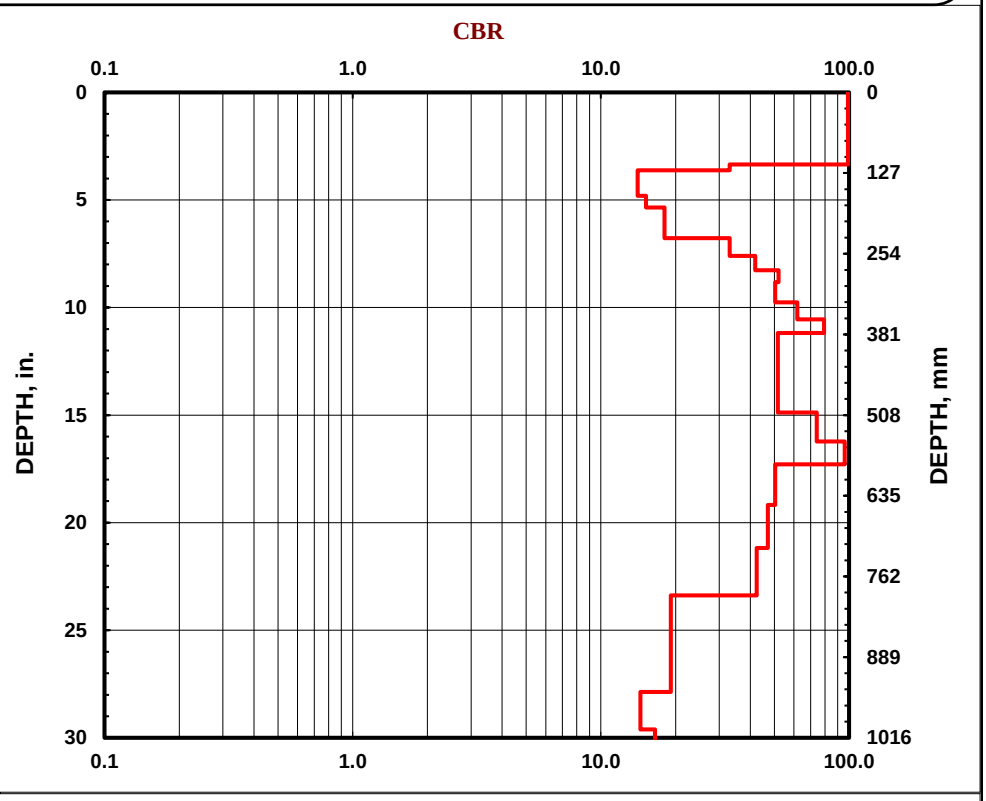
Project: *Farmington Regional Center* **Date:** 24-May-24

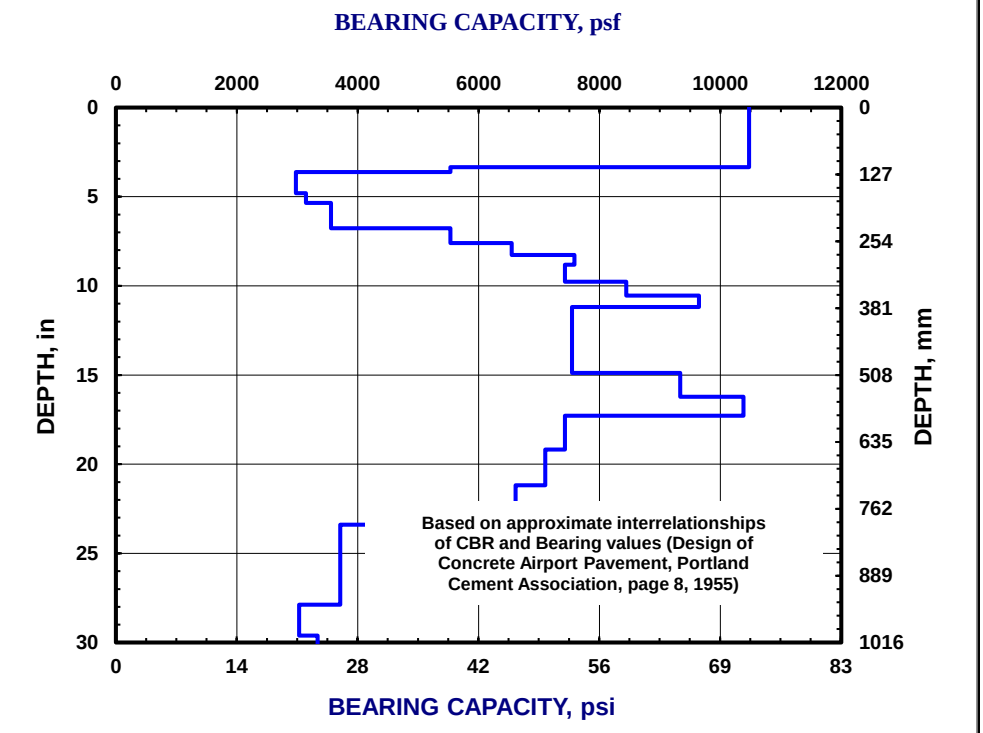
Location: B-4 **Soil Type(s):**

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	2
0	85	1
1	92	1
1	107	1
1	122	1
1	136	1
3	172	1
3	193	1
3	210	1
3	224	1
5	248	1
5	268	1
5	284	1
10	331	1
10	378	1
10	412	1
10	439	1
10	487	1
10	538	1
10	594	1
10	708	1
3	752	1
3	791	1
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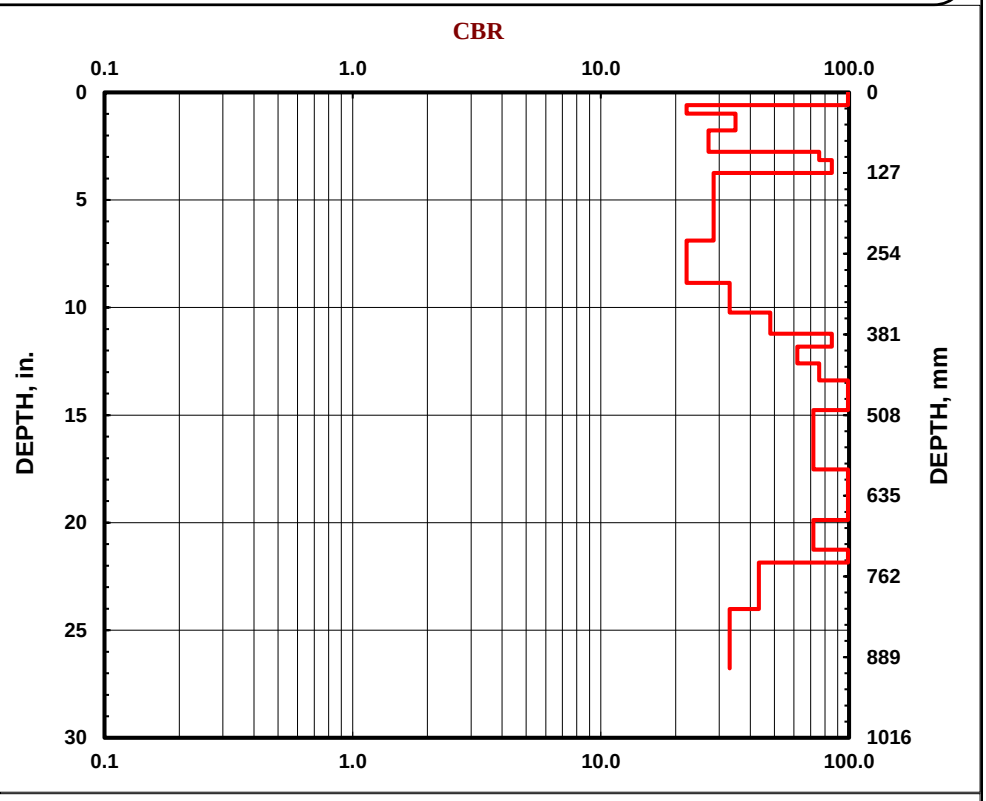
Project: *Farmington Regional Center* **Date:** 24-May-24

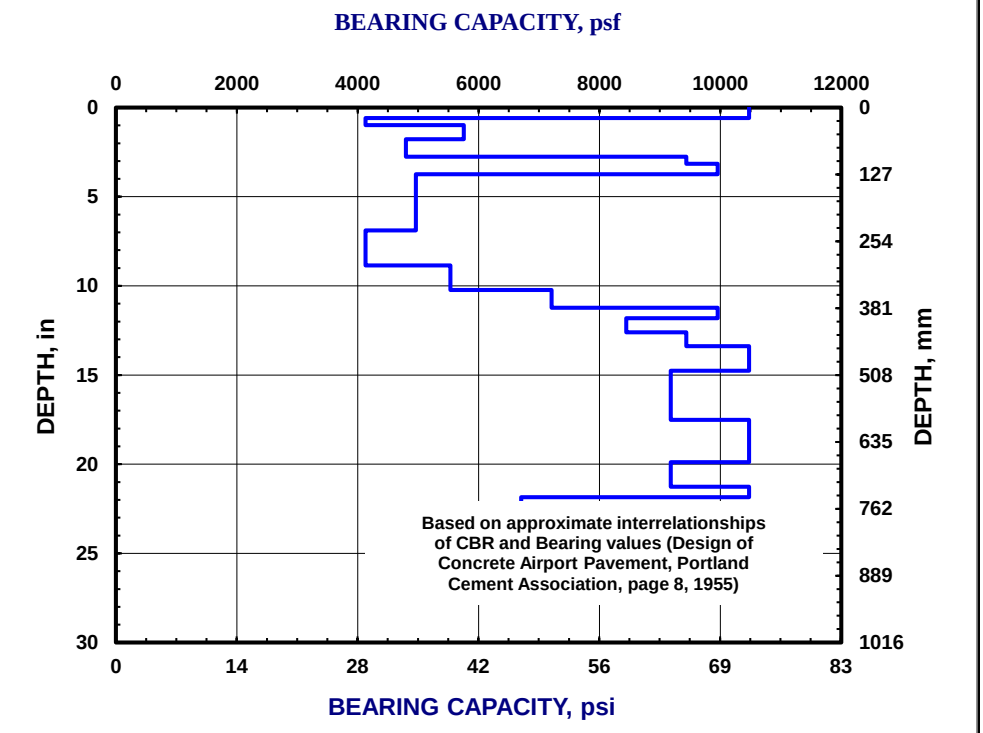
Location: B-5 **Soil Type(s):**

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	2
0	15	1
1	25	1
3	45	1
3	70	1
3	80	1
5	95	1
10	175	1
5	225	1
5	260	1
5	285	1
5	300	1
5	320	1
6	340	1
55	360	1
10	375	1
10	410	1
10	445	1
10	465	1
10	480	1
10	505	1
10	540	1
10	555	1
10	610	1
10	680	1
0	0	1
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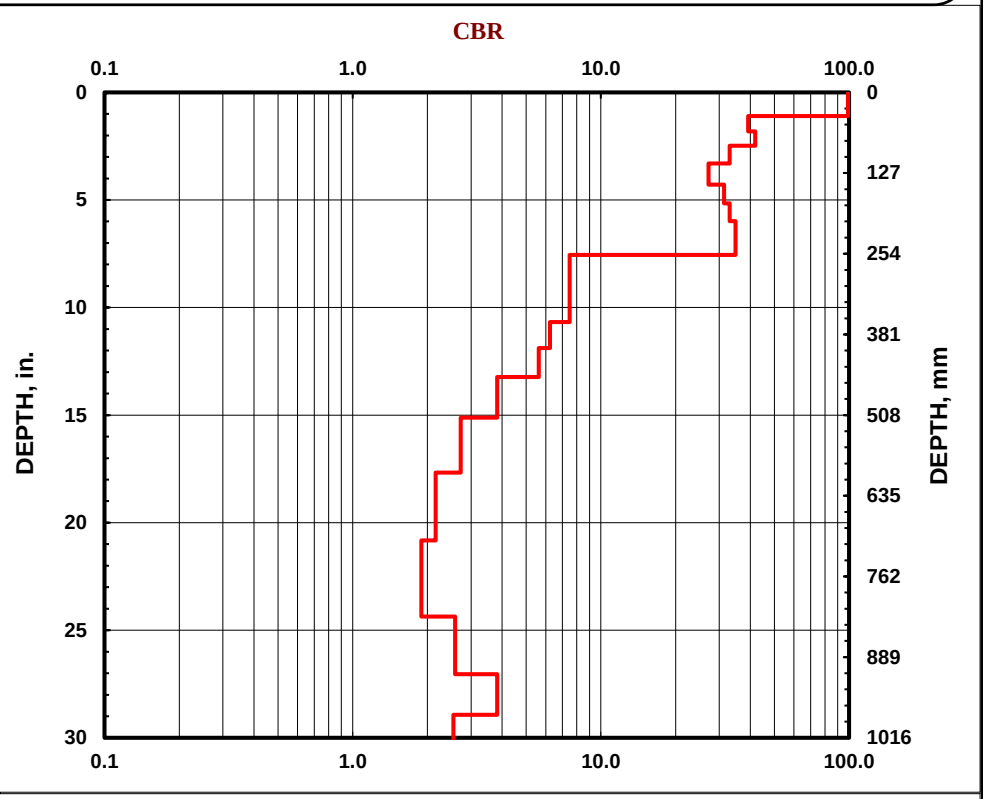
Project: *Farmington Regional Center* **Date:** 24-May-24

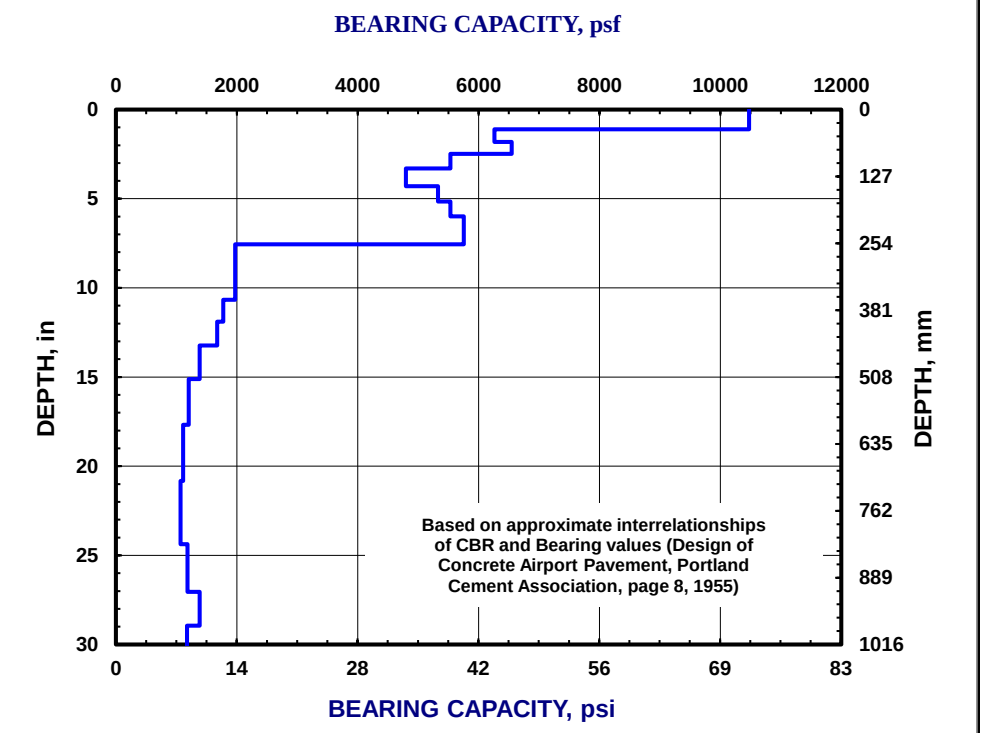
Location: B-6 **Soil Type(s):** CLAY (CL)

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ◉ CL
- ○ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	2
0	28	1
3	46	1
3	63	1
3	84	1
3	109	1
3	131	1
3	152	1
3	172	1
3	192	1
3	271	1
1	302	1
1	336	1
1	384	1
1	449	1
1	529	1
1	619	1
1	687	1
1	735	1
1	804	1
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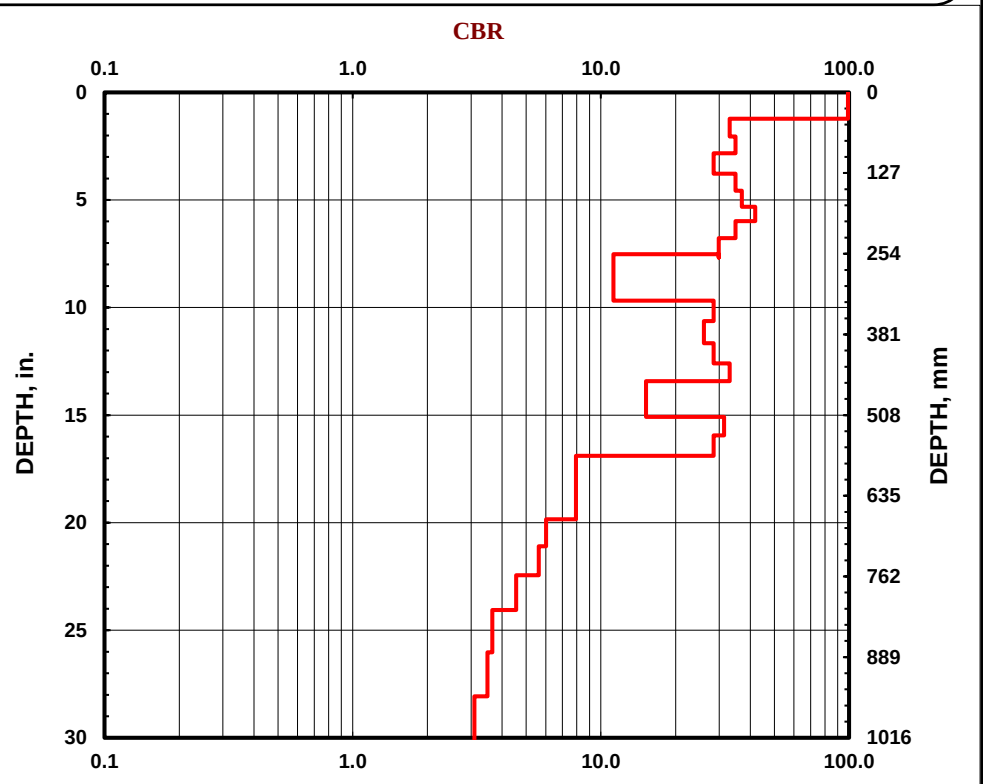
Project: *Farmington Regional Center* **Date:** 24-May-24

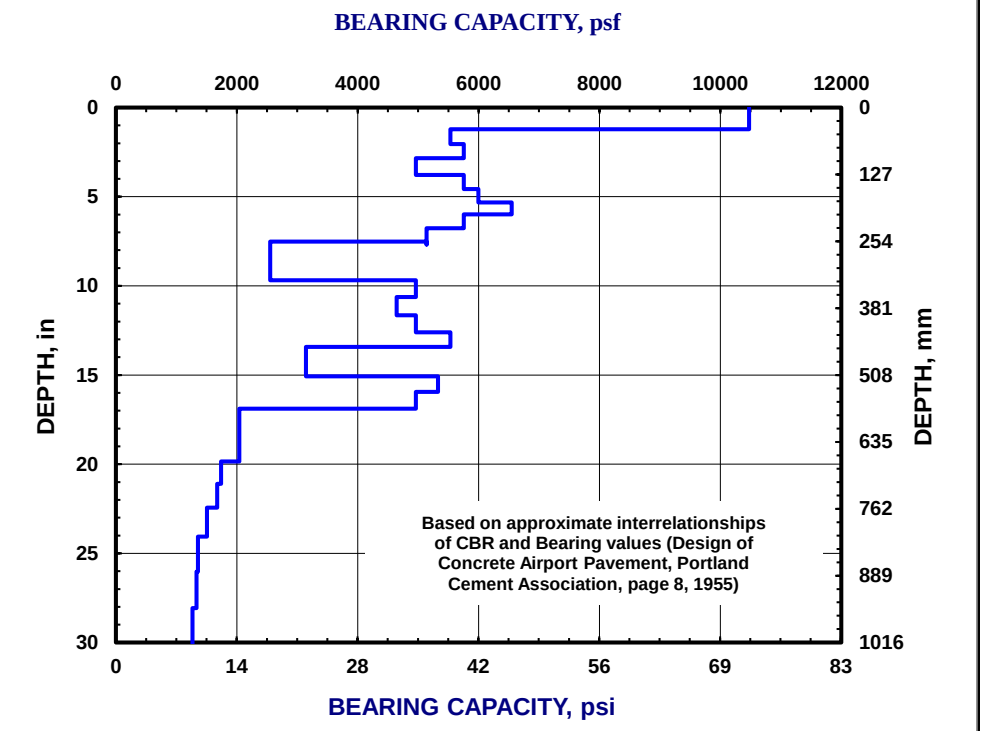
Location: B-7 **Soil Type(s):**

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ◉ CL
- ○ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	2
0	31	1
3	52	1
3	72	1
3	96	1
3	116	1
3	135	1
3	152	1
3	172	1
3	195	1
3	191	1
3	246	1
3	270	1
3	296	1
3	320	1
3	341	1
3	383	1
3	405	1
3	429	1
3	504	1
1	536	1
1	570	1
1	611	1
1	661	1
1	713	1
1	771	1
0	0	1
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CMT TECHNICAL SERVICES



ENGINEERING •GEOTECHNICAL •ENVIRONMENTAL (ESA I & II) •
MATERIALS TESTING •SPECIAL INSPECTIONS •
ORGANIC CHEMISTRY • PAVEMENT
DESIGN •GEOLOGY

SITE-SPECIFIC GROUND MOTION HAZARD ANALYSIS

Farmington Regional Center

About 500 North Lagoon Drive
Farmington, Utah

CMT PROJECT NO. 22203

FOR:
ajc architects
703 East 1700 South
Salt Lake City, Utah 84105

July 3, 2024

July 3, 2024

Ms. Jill Jones
ajc architects
703 East 1700 South
Salt Lake City, Utah 84105

Subject: **Site-Specific Ground Motion Hazard Analysis**
Farmington Regional Center
About 500 North Lagoon Drive
Farmington, Utah
CMT Project Number: 22203

Ms. Jones:

Submitted herewith is the report of our site-specific ground motion hazard analysis for the subject site. The results of our analysis include classification of the site, site-specific seismic values for design, and response spectra for design. This report satisfies the requirements of ASCE 7-16 and IBC 2021 for seismic site-specific ground motion hazard analysis. Detailed discussions of our analysis parameters, values and results are presented in this report.

We appreciate the opportunity to work with you at this stage of the project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With offices throughout Utah, Idaho, Texas, Colorado and Arizona, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 590-0394.

Sincerely,

CMT Technical Services

LICENSED PROFESSIONAL ENGINEER
171715
WILLIAM G.
TURNER
7/3/24
STATE OF UTAH

William G. Turner, P.E.
Senior Geotechnical Engineer

Reviewed by:

Andrew M. Harris, P.E.
Geotechnical Division Manager

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APPENDIX A
EZ-FRISK Data/Output (200 Pages)

APPENDIX B
Seismic Velocity Survey Results (7 Pages)
Ground Motion Hazard Analysis Summary (16 pages)
OSHPD Report (1 Page)

1.0 INTRODUCTION

1.1 General

CMT Technical Services (CMT) was retained to conduct a site-specific ground motion hazard analysis for the proposed Farmington Regional Center office building. The site is situated on the north side of Lagoon Drive at about 500 North in Farmington, Utah, as shown in **Exhibit 1 - Vicinity Map** below.



EXHIBIT 1 - VICINITY MAP

1.2 Objectives, Scope and Authorization

The objectives and scope of our study were planned in discussions between Ms. Jill Jones with ajc architects, and Mr. Andrew Harris of CMT. In general, the objectives of this study were to obtain a shear wave velocity profile of at least the upper 100 feet from the existing ground surface, and provide a site-specific ground motion hazard analysis to be utilized in the design of proposed buildings.

In accomplishing these objectives, our scope of work has included performing in-situ shear wave velocity testing, performing a site-specific ground motion hazard analyses for the site, and preparing this summary report. This scope of work was authorized via our master consultant agreement in relation to our proposal dated May 12, 2024.

1.3 Description of Proposed Construction

We understand that the proposed construction consists of an office building with a plan area of approximately 35,000 square which will be 1 to 2 levels above grade with surface parking. We project that wall loads will not exceed 6,000 pounds per linear foot and column loads will not exceed 100,000 pounds. Floor slab loads are anticipated to be relatively light, with an average uniform loading not exceeding 150 pounds per square foot.

1.4 Executive Summary

Based on the results of the seismic velocity testing at the site, an average shear wave velocity in the upper 100 feet (30 meters, or $V_{s,30}$) of 777 feet per second (237 meters per second) was obtained. Given these shear-wave velocity results, we recommend the project site be classified as Site Class D – Stiff Soil profile (with data) for seismic design.

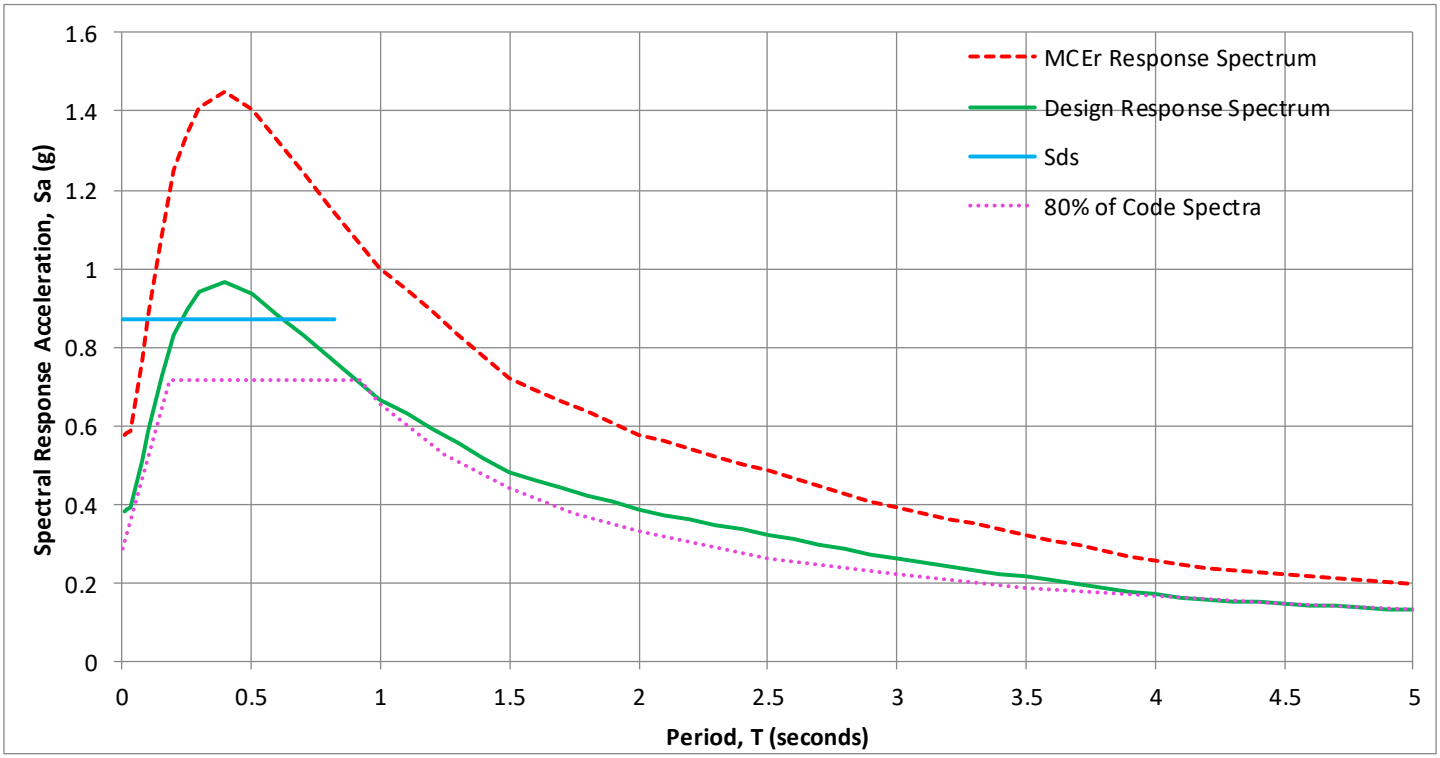
The results of the site-specific ground motion hazard analyses, performed in accordance with ASCE[1] 7-16 Chapter 21, are presented herein, including the risk-targeted uniform hazard MCE_R and design response spectra. The site-specific design and MCE_R spectral response acceleration parameters are shown in the table below. The final site-specific MCE_R and design response spectra are also shown below.

[1]American Society of Civil Engineers

SPECTRAL ACCELERATION VALUE, T	SITE CLASS B/C BOUNDARY [mapped values] (g)	SITE CLASS D [GMHA Results] (g)	MULTIPLIER	DESIGN VALUES (g)
Peak Ground Acceleration	PGA_M = **0.735**	PGA_M = 0.575	1.000	PGA_M = 0.575
0.2 Seconds (Long Period Acceleration)	S_S = **1.338**	S_{MS} = 1.303	0.667	S_{DS} = 0.869
1.0 Second (Long Period Acceleration)	S_1 = **0.494**	S_{M1} = 1.210	0.667	S_{D1} = 0.807

NOTES: *** Site Class D With Data**

1. T_L (seconds): **8**
2. Site Class: **D**
3. Have data to verify? **Yes**



2.0 GEOLOGIC & SITE CONDITIONS

2.1 Geologic Setting

The subject site is in the east-central portion of Davis County in north-central Utah and sits at an elevation of approximately 4,272 feet above sea level in a valley bounded by the Wasatch Mountains on the east and Antelope Island (Great Salt Lake) and the Promontory Mountains on the west. The valley is a deep, sediment-filled basin that is part of the Basin and Range Physiographic Province, formed by extensional tectonic processes during the Tertiary and Quaternary geologic time periods. The valley is located within the Intermountain Seismic Belt, a zone of ongoing tectonism and seismic activity extending from southwestern Montana to southwestern Utah. The active (evidence of movement in the last 10,000 years) Wasatch Fault Zone is part of the

Intermountain Seismic Belt and extends from southeastern Idaho to central Utah along the western base of the Wasatch Mountain Range.

Much of northwestern Utah, including the valley in which the subject site is located, was also previously covered by the Pleistocene age Lake Bonneville. The Great Salt Lake, located along the western margin of the valley and beyond, is a remnant of this ancient freshwater lake. Lake Bonneville reached a high-stand elevation of between approximately 5,160 and 5,200 feet above sea level at between 18,500 and 17,400 years ago. Approximately 17,400 years ago, the lake breached its basin in southeastern Idaho and dropped by almost 300 feet relatively fast as water drained into the Snake River. Following this catastrophic release, the lake level continued to drop slowly over time, primarily driven by drier climatic conditions, until reaching the current level of the Great Salt Lake. Shoreline terraces formed at the high-stand elevation of the lake and several subsequent lower lake levels are visible in places on the mountain slopes surrounding the valley. Much of the sediment within the valley was deposited as lacustrine sediments during both the transgressive (rise) and regressive (fall) phases of Lake Bonneville and in older, pre-Bonneville lakes that previously occupied the basin.

The geology of the USGS Farmington, Utah 7.5 Minute Quadrangle, that includes the location of the subject site, has been mapped by Lowe and others[2]. The surficial geology of the southeastern portion of the site is mapped as "Younger alluvial-fan deposits" (Map Unit Qaf_1) dated to be upper Holocene. Unit Qaf_1 is described in the referenced map as "Mixture of gravel and sand deposited by streams, and diamicton deposited by debris flows; forms fans, locally with distinct levees and channels, at mouths of mountain-front canyons; exposed thickness less than 6 meters (20 ft)." The northwestern portion of the site is mapped as "Fill and disturbed land (historical)" (Map Unit Qfd). Unit Qfd is described as "Land disturbed and excavated through aggregate (sand and gravel) operations and construction of Interstate highways, highway interchanges, and Farmington Bay dikes." Refer to **Exhibit 2 - Geologic Map**, shown below:

[2]Lowe, M., Kirby, S.M., and Harty, K.M., 2018, Geologic Map of the Farmington Quadrangle, Salt Lake and Davis Counties, Utah; Utah Geological Survey Map 279 DM, Scale 1:24,000.

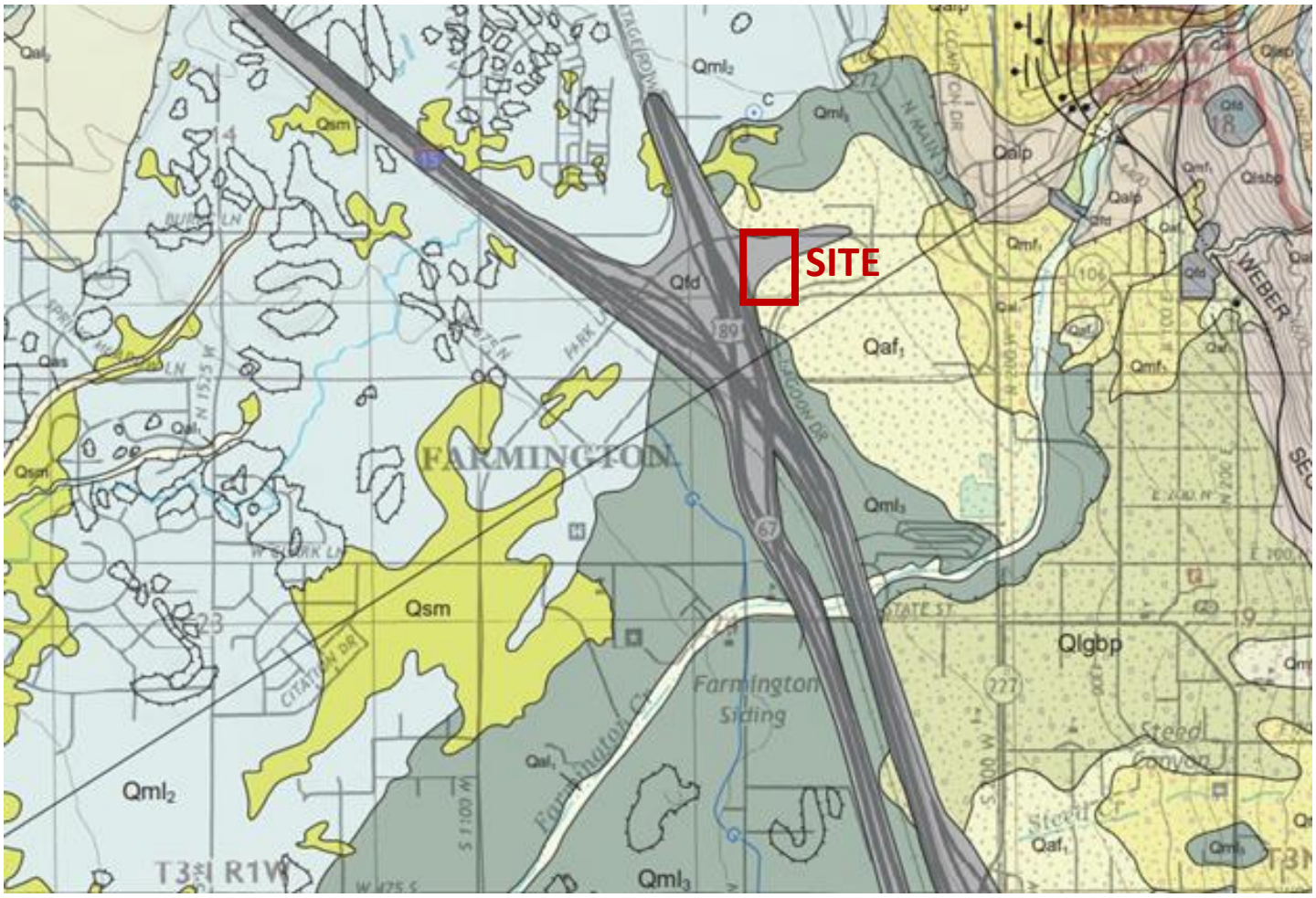


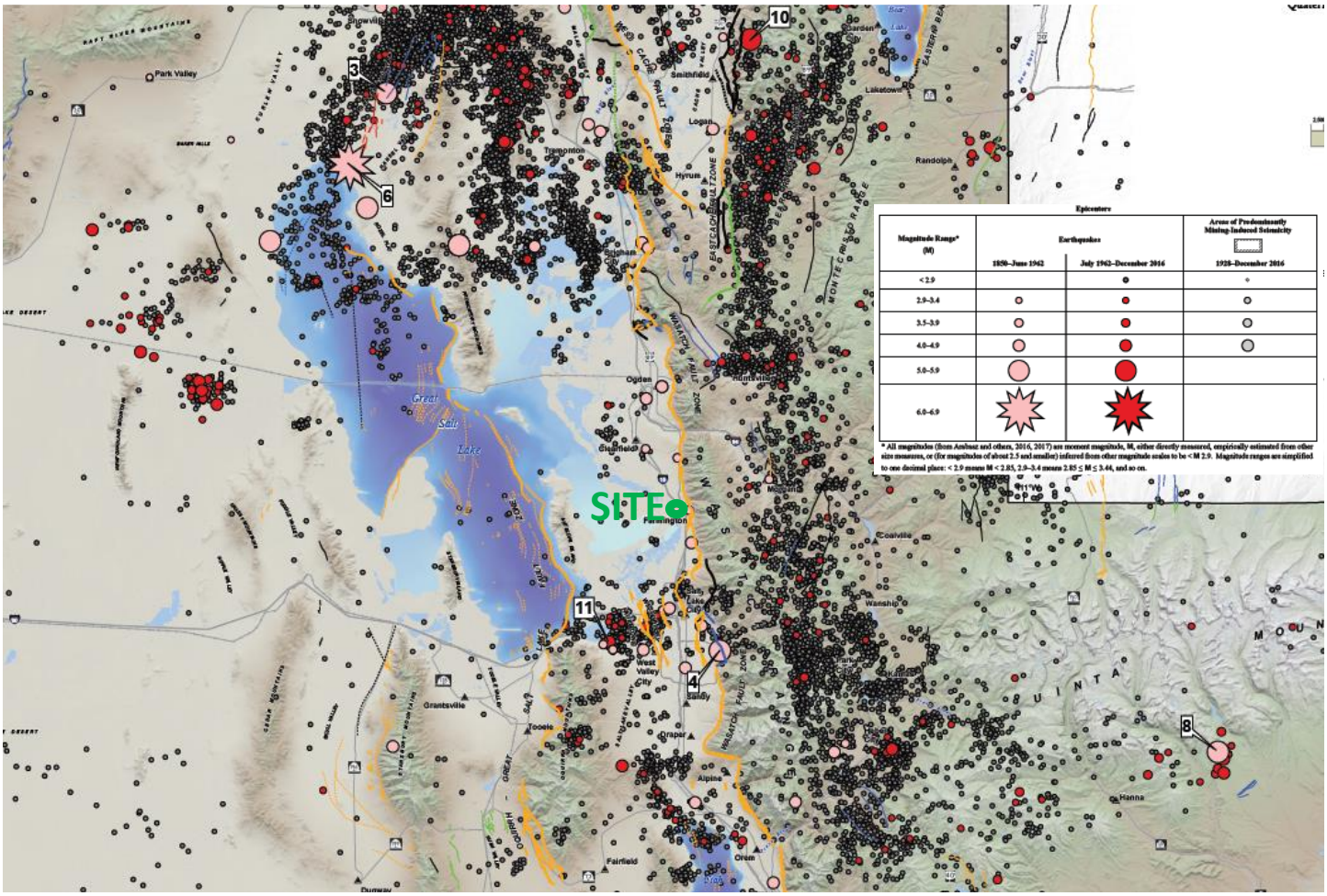
EXHIBIT 2 - GEOLOGIC MAP

2.2 Faulting

The referenced geologic map does not show any faults crossing, adjacent to, or projecting toward the subject site. The nearest mapped active (Holocene-age) fault is the Weber Segment of the Wasatch Fault Zone approximately 0.6 miles to the northeast.

Fault sources included in this study are listed in the analysis results included in **Appendix A** and included faults within 200 kilometers (124 miles) of the site within Utah, southern Idaho, western Wyoming and eastern Nevada. Gridded sources have been included for background seismicity. Historical seismicity within approximately 60 miles of the site is shown in the **Historical Earthquakes and Regional Fault Map**[3], shown below.

[3]Bowman, S.D. and Arabasz, W.J., 2017, Utah Earthquakes (1850-2016) and Quaternary Faults; Utah Geological Survey Map 277, Scale 1:500,000.



HISTORICAL EARTHQUAKES AND REGIONAL FAULT MAP

2.3 Other Geologic Hazards

This site is not at risk from surface-fault-rupture, rock fall, debris flow, stream flooding or fan flooding. Our evaluation as presented in our geotechnical report (dated July 2, 2024, under separate cover) indicates that some isolated layers of the saturated sand layers could liquefy during a design seismic event, but we estimated the amount of settlement expected at the surface would be less than 1 inch and no lateral spreading would occur; thus, liquefaction mitigation is likely not needed.

2.4 Surface Conditions

At the time the bore holes were drilled, the site was vacant and vegetated with grasses, weeds, and a line of trees through the central portion of the site. Overall, the site is relatively flat, with a very slight slope downward to the west. Based upon aerial photos dating back to 1993 that are readily available on the internet, the site appears to have remained relatively unchanged since then. The aerial photos also indicate the portion for the site south of the line of trees has generally remained more verdant than the area to the north of the line of trees. The site is bordered on the north by 675 North Street, on the south by Lagoon Drive, on the east by a

State Liquor Store, and on the west by the Highway 89 northbound off-ramp (see **Vicinity Map** in **Section 1.1** above).

2.5 Subsurface Conditions

Our referenced geotechnical report for this site indicates the subsurface soils at this site consist of topsoil at the surface underlain by natural layers of clay and silt grading with layers of sand and an occasional layer of gravel, extending to the maximum depth penetrated, 51.5 feet below the existing ground surface. Groundwater was encountered and/or measured at depths of about 5.6 to 24 feet.

2.6 Seismic Site Class

Utah has adopted the International Building Code (IBC) 2021, which determines the seismic hazard for a site based upon 2014 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points). For site class definitions, IBC 2021 Section 1613.2.2 refers to Chapter 20, Site Classification Procedure for Seismic Design, of ASCE 7-16. The site classification procedure is based on shear wave velocity, blow counts during drilling, and/or shear strength of cohesive soils within the upper 100 feet (30 meters) of the soil profile.

The site is located at approximately latitude 40.9904 degrees (north) and longitude -111.9005 degrees (west). Site characterization was performed using seismic surface waves methods performed by IGES (results are presented in ***Appendix B***). The results of these analyses indicate that the average shear wave velocity of the upper 100 feet (30 meters) below the ground surface (i.e., $V_{S,30}$) at the site is approximately 777 feet per second (237 meters per second). Given these results, we recommend the project site be classified as Site Class D – Stiff Soil Profile (with data) for seismic design.

3.0 SEISMIC HAZARD ANALYSIS

3.1 General

ASCE 7-16 requires performing both probabilistic and deterministic seismic hazard analyses (PSHA and DSHA) in order to develop the site-specific MCE_R and design response spectra. These analyses involve the selection of appropriate predictive relationships to estimate the ground motion parameters, and through probabilistic and deterministic methods, determination of peak and spectral accelerations. Our analyses, which are detailed in ***Appendix A*** and summarized in ***Appendix B***, were primarily performed using the *EZ-FRISK (Version 8.07)* software with the following input items:

- Our seismic source model was based on the USGS 2014 National Seismic Hazard Maps[4], including the locations of the sources and associated parameters used in our analyses.

[4] Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, Ned, Chen, Rui, Rukstales, K.S., Luco, Nico, Wheeler, R.L., Williams, R.A., and Olsen, A.H. (2014). "Documentation

- In addition to the individual seismic sources, we also allowed for background (i.e., gridded) seismicity that accounted for random earthquakes between Magnitudes 5.0 and 7.0 based on the methodology described by Petersen et al.[4,5] and Frankel et al.[6]. The seismic source model developed by USGS does not include all of the local Quaternary faults in the seismic hazard analyses as independent seismic sources, but their seismicity has been included within the background seismicity in our model.

- The Wasatch Front area began to be settled around 1847. Since that time, several moderate intensity and many low intensity earthquakes have occurred in the general vicinity of the site, including the most recent Magnitude 5.7 earthquake in March 2020, where the epicenter was a few miles west of Salt Lake City and about 20 miles southwest of the project site. The **Historical Earthquakes and Regional Fault Map** presented above in **Section 2.2** shows the locations and relative magnitudes of historical earthquake ground shaking within about 60 miles (97 km) of the site. Historical seismicity in the site vicinity is useful to confirm the frequency of seismic events on faults used in seismic hazards analysis.

For the CEUS gridded sources, we used the ground motion prediction equations (GMPE's) listed below along with the weighting presented in the documentation for the 2014 Update of the United States National Seismic Hazard Maps[5]:

- Frankel (1996, Truncated Mw)
- Toto (1999, Midcontinent)
- Silva et al. (2002)
- Campbell (2003)
- Tavakoli-Pezeschk (2005)
- Atkinson-Boore (2006)
- Pezeshk et al. (2011)
- Atkinson (2008)

For all other sources, we selected the most recent NGA-West2 (Next Generation of Ground-Motion Attenuation Models for the Western United States) GMPE's listed below with equal weighting of 0.25 each (Idriss, 2014, was not included since the shear wave velocity is less than 450 meters per second).

- Abrahamson et al. (2014)
- Boore et al. (2014)
- Campbell and Bozorgnia (2014)
- Chiou and Youngs (2014)

for the 2014 update of the United States national seismic hazard maps." U.S. Geological Survey Open-File Report 2014–1091, 243 p., http://dx.doi.org/10.3133/ofr20141091.

[5] Petersen, M.D., Frankel, A.D., Harmsen, S.C., Mueller, S.C., Haller, K.M., Wheeler, R.L., Wesson, R.L., Zeng, Y., Boyd, O.S., Perkins, D.M., Luco, N., Field, E.H., Wills, C.J., and Rukstales, K.S. (2008). "Documentation for the 2008 Update of the United States National Seismic Hazard Maps", USGS Open-File Report 2008-1128, 128p.

[6] Frankel, A.D., Petersen, M.D., Mueller, C.S., Haller, K.M., Wheeler, R.L., Leyendecker, E.V., Wesson, R.L., Harmsen, S.C., Cramer, C.H., Perkins, D.M., and Rukstales, K.S. (2002). "Documentation for the 2002 Update of the National Seismic Hazard Maps", United States Geological Survey, Open-File Report 02-420, 33 pp., URL http://geohazards.cr.usgs.gov/eq/of02-420/OFR02-420.pdf.

Site-specific parameters for the selected GMPE's include $V_{s,30}$ (measured as 237 meters per second), depth to a shear wave velocity of 1.0 kilometers per second ($Z_{1.0}$), and depth to a shear wave velocity of 2.5 kilometers per second ($Z_{2.5}$). To obtain both these values, we used extrapolation from the shear-wave velocity measurements, the method of Moschetti et al[7], and the closest geologic cross-section to the site as provided on the geologic map prepared by Bryant[8]. To obtain a depth where the shear wave velocity would be approximately 1,000 meters per second, we obtained the following values:

- Utilizing the Moschetti et al[7] method indicated a depth of roughly 400 meters.
- Extrapolation of the shear wave velocity data from the site characterization resulted in a depth of about 400 meters.

Using an average of these methods resulted in an average of 400 meters for the $Z_{1.0}$ value. To obtain a depth where the shear wave velocity would be approximately 2,500 meters per second, we obtained the following values:

- Utilizing the Moschetti et al[8] method indicated a depth of roughly 2,700 meters.
- Extrapolation of the shear wave velocity data from the site characterization resulted in a depth of about 1,240 meters (this value was not used because it was not within 20% of the average of the other two values)
- Using cross-section C-C' from the geologic map of Bryant[8] (referenced above) indicated a depth of about 2,600 meters.

Using an average of the first and third methods resulted in 2,650 meters (2.65 kilometers) for the $Z_{2.5}$ value. Details of the methods used and calculations for our analyses, including applicable sections of ASCE 7-16, are presented on the ***GMHA Summary*** provided in ***Appendix B***.

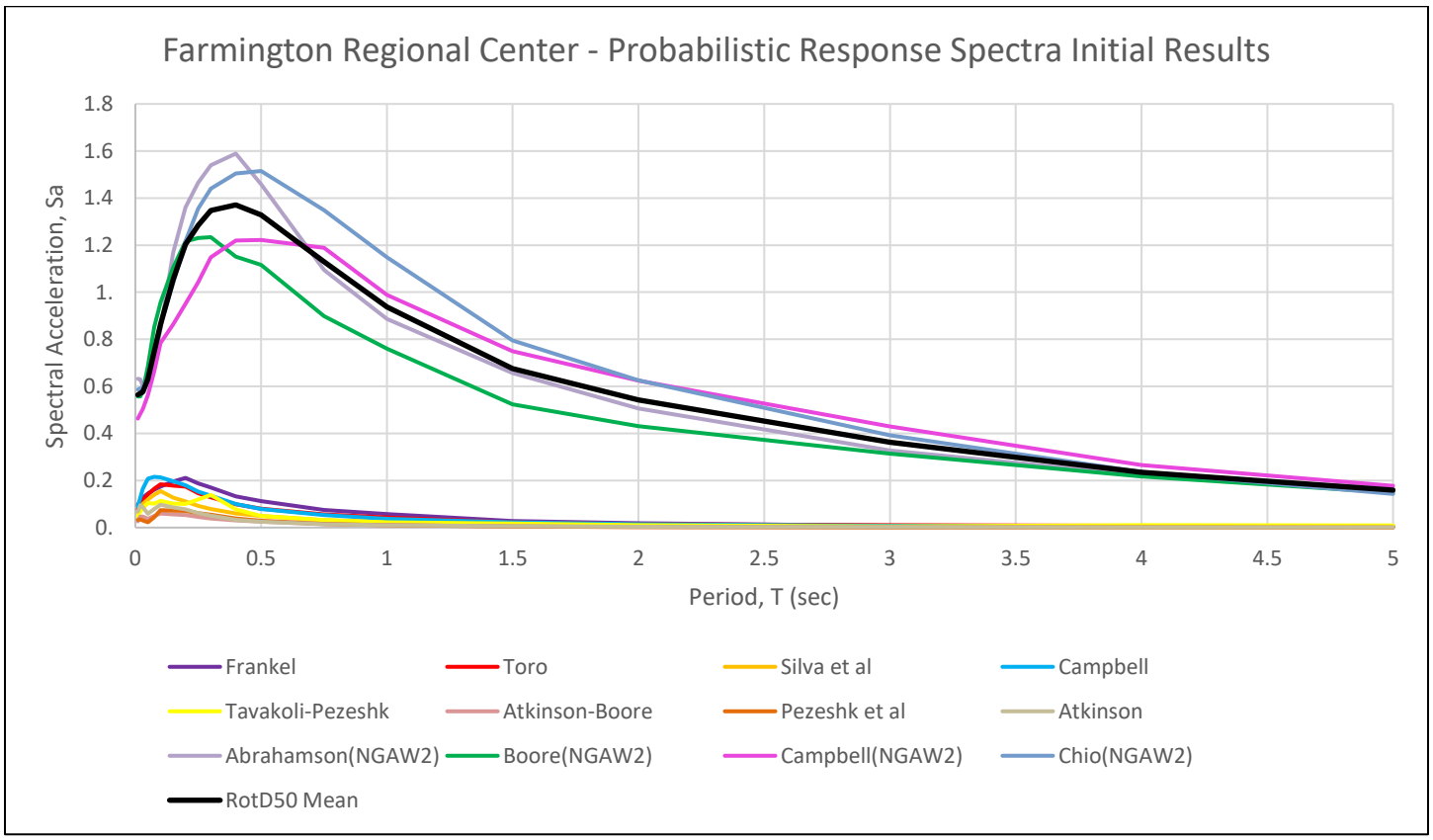
3.2 Probabilistic Seismic Hazard Analysis

ASCE 7-16 §11.4.1 defines near-fault sites as those being within 15 km (9.5 miles) of the surface projection of faults capable of producing larger than Mw 7 earthquakes, which would include the Wasatch fault. With the project site being less than 9.5 miles from the active Weber segment of the Wasatch fault, we accounted for directivity effects of near-fault conditions using the method presented by Bayless and Somerville[9]. The initial results of the probabilistic spectrum for each of the GMPEs used are shown below.

[7] Moschetti, M.P., Hartzell, S., Ramírez-Guzmán, L., Frankel, A.D., Angster, S.J., and Stephenson, W.J. (2017). 3D Ground-Motion Simulations of Mw 7 Earthquakes on the Salt Lake City Segment of the Wasatch Fault Zone: Variability of Long-Period (T≥1 s) Ground Motions and Sensitivity to Kinematic Rupture Parameters. Bulletin of the Seismological Society of America published ahead of print June 20, 2017, doi:10.1785/0120160307.

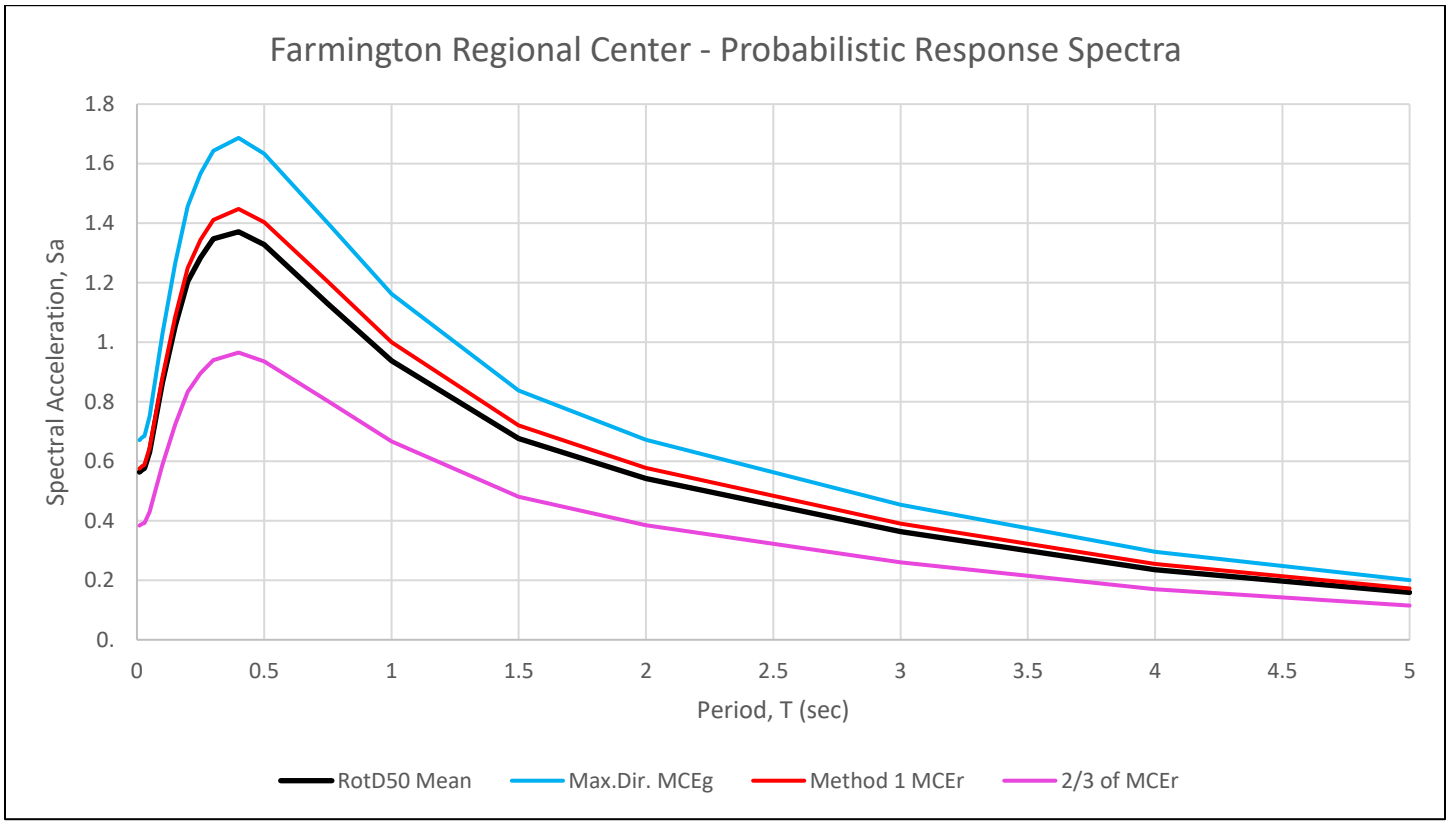
[8] Bryant, B., 1990, Geologic Map of the Salt Lake City, 30' x 60' Quadrangle, North-Central Utah and Uinta County, Wyoming, USGS Map I-1944.

[9] Bayless, J., and Somerville, P. (2013). "Bayless-Somerville Directivity Model, Chapter 3 of PEER Report No. 2013/09", P. Spudich (Editor), Pacific Earthquake Engineering Research Center, Berkeley, CA



The values obtained as shown above are calculated as the geo-mean spectral accelerations in the horizontal plane (RotD50). ASCE 7-16 Section 21.2 requires that maximum accelerations in the horizontal plane (RotD100) be used for the spectral response. Section 21.2 also provides default directivity scaling factors, but allows the use of other appropriate scaling factors. For our analysis, we used the scaling factors presented by Shahi and Baker[10] to obtain the corrected (RotD100) spectral values for the mean spectrum shown above (in black). These corrected values were then adjusted for risk using the mapped risk coefficients C_{RS} and C_{R1}, 0.864 and 0.882, respectively, estimated from Figures 22-17 and 22-18 of ASCE 7-16 (see ***OSHPD Results*** in ***Appendix B***). These risk coefficients were used to modify the mean probabilistic spectral response accelerations (shown above) per Method 1 of Section 21.2.1 of ASCE 7-16 by multiplying with C_{RS} for periods up to and including 0.2 seconds, with C_{R1} for periods higher than and including 1.0 second, and using linear interpolation between 0.2 and 1.0 seconds. These adjustments resulted in the probabilistic risk-targeted (MCE_R) response spectrum, as shown (in red) below.

[10] Shahi, S.K., and Baker, J.W. (2014). "NGA-West2 Models for Ground Motion Directionality". Earthquake Spectra, 30(3), pp. 1285-1300.



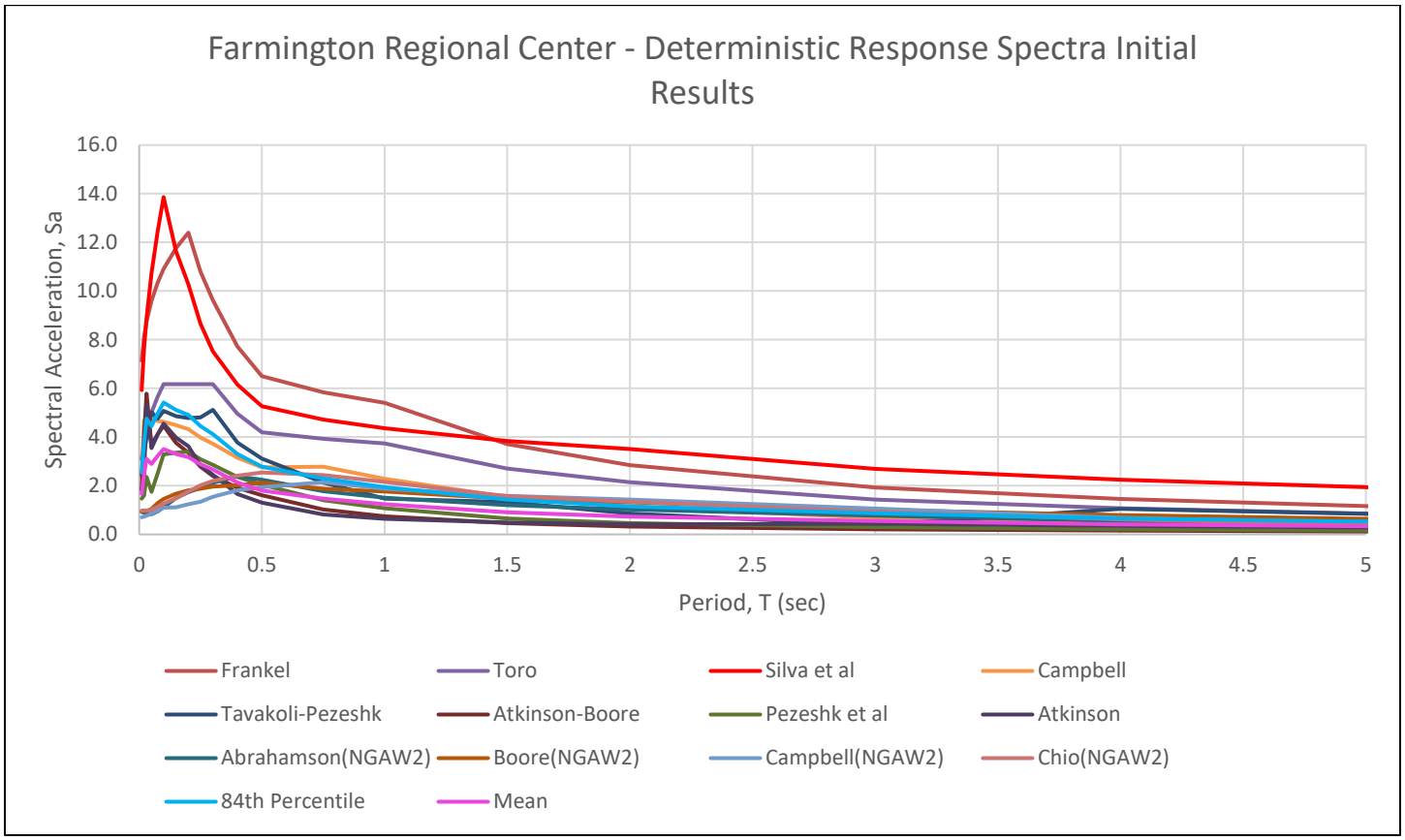
3.3 Deterministic Seismic Hazard Analysis

The Deterministic Seismic Hazard Analysis (DSHA) was also performed using the GMPE's listed above. This analysis was based on seismic characteristics, such as distance from the site to the causative fault and maximum magnitude of the earthquake associated with that fault, as listed in the summary table below for faults located within 200 kilometers (124 miles) of the site.

Source	Region	Closest Deterministic Fault		Dip Angle/ Dips To:	Site Lies:
		Distance (km)	Magnitude (Mw)/ Mechanism		
CEUS Gridded Source	USGS 2014 CEUS Gridded Source	0	0.0000 Strike Slip	90.0000 --	Above
Shallow - Extensional Gridded	USGS 2014 WUS Gridded Source	0	8.0000 N|SS	90.0000 --	Above
Wasatch fault, Weber section [2351e]	USGS 2014 Utah	0.74	7.1600 Normal	35-65 W	SW
Salt Lake City - Wasatch Fault Source Model	USGS 2014 Utah	0.78	7.4010 N|SS	35-90 W	Above
Morgan fault [2353abc]	USGS 2014 Utah	11.67	6.5200 Normal	35-65 W	SW
West Valley fault [2386]	USGS 2014 Utah	18.84	6.5000 Normal	35-65 E	N
W65G35 West Valley (Wasatch 65) fault (dip 35)	USGS 2014 Utah	19.22	6.5000 Normal	35.0000 E	N
W50G35 West Valley (Wasatch 50) fault (dip 35)	USGS 2014 Utah	19.63	6.5000 Normal	35.0000 E	N
W35G35 West Valley (Wasatch 35) fault (dip 35)	USGS 2014 Utah	20.21	6.5000 Normal	35.0000 E	N
W65G50 West Valley (Wasatch 65) fault (dip 50)	USGS 2014 Utah	20.81	6.5000 Normal	50.0000 E	N
W50G50 West Valley (Wasatch 50) fault (dip 50)	USGS 2014 Utah	20.94	6.5000 Normal	50.0000 E	N

Source	Region	Closest Deterministic Fault		Dip Angle/ Dips To:	Site Lies:
		Distance (km)	Magnitude (Mw)/ Mechanism		
W35G50 West Valley (Wasatch 35) fault (dip 50)	USGS 2014 Utah	21.32	6.5000 Normal	50.0000 E	N
W50G65 West Valley (Wasatch 50) fault (dip 65)	USGS 2014 Utah	22.45	6.5000 Normal	65.0000 E	N
W65G65 West Valley (Wasatch 65) fault (dip 65)	USGS 2014 Utah	22.45	6.5000 Normal	65.0000 E	N
W35G65 West Valley (Wasatch 35) fault (dip 65)	USGS 2014 Utah	22.46	6.5000 Normal	65.0000 E	N
Great Salt Lake fault zone, Antelope Island [2369c]	USGS 2014 Utah	30.45	6.9300 Normal	35-65 W	NE
Great Salt Lake fault zone, Fremont Island s [2369b]	USGS 2014 Utah	34.02	6.8300 Normal	35-65 SW	E
Wasatch fault, Brigham City section [2351d]	USGS 2014 Utah	34.9	6.9500 Normal	35-65 W	SE
Oquirrh-Southern Oquirrh Mountains fault [2398_2399]	USGS 2014 Utah	44.31	7.1700 Normal	35-65 W	NE
East Cache fault zone [2352abc]	USGS 2014 Utah	48.95	7.3100 Normal	35-65 W	S
Great Salt Lake fault zone, Promontory secti [2369a]	USGS 2014 Utah	51.84	7.0900 Normal	35-65 SW	SE
Wasatch fault, Provo section [2351g]	USGS 2014 Utah	55.45	7.2700 Normal	35-65 W	N
West Cache fault, Wellsville section [2521c]	USGS 2014 Utah	65.52	6.6000 Normal	35-65 NE	S
Stansbury fault zone [2395]	USGS 2014 Utah	72.1	7.0900 Normal	35-65 W	NE
Bear River fault zone [730]	USGS 2014 Wyoming	72.47	6.9000 Normal	35-65	W
West Cache fault zone, Junction Hills fault [2521b]	USGS 2014 Utah	78.3	6.7000 Normal	35-65 NE	S
Hansel Valley fault [2358]	USGS 2014 Utah	89.85	6.6000 Normal	35-65 E	SE
Eastern Bear Lake fault [2364abc]	USGS 2014 Idaho	91.38	7.2900 Normal	35-65 W	S
North Promontory fault [2361]	USGS 2014 Nevada	96.7	6.7300 Normal	35-65 W	SE
Strawberry fault [2412]	USGS 2014 Utah	97.07	6.9200 Normal	35-65 W	NW
Wasatch fault, Nephi section [2351h]	USGS 2014 Utah	100.23	7.0100 Normal	35-65 W	N
West Cache fault, Clarkston section [2521a]	USGS 2014 Utah	101.62	6.6600 Normal	35-65 E	S
Rock Creek fault [729]	USGS 2014 Wyoming	116.95	6.9500 Normal	35-65 W	SW
Wasatch fault, Levan section [2351i]	USGS 2014 Utah	149.83	6.8300 Normal	35-65 W	N
Joes Valley fault zone [2455]	USGS 2014 Utah	160.39	7.0200 Normal	35-65 W	N
Grand Valley fault [726c]	USGS 2014 Wyoming	182.6	7.1000 Normal	35-65 W	S
Greys River fault [728]	USGS 2014 Wyoming	193.01	7.0500 Normal	35-65 W	SW

Local soil conditions are also accounted for within the GMPEs used for this study, as mentioned above. The accelerations calculated for characteristic earthquakes on all known active faults and background (gridded) earthquakes in the vicinity of the site were utilized to obtain the 84th percentile and mean results presented below and in ***Appendix A***. With the project site being within 15 km of the Wasatch fault (Weber segment), we accounted for directivity effects of near-fault conditions using the method presented by Bayless and Somerville[9] (see referenced in **Section 3.2** above). The initial results of the deterministic spectrum for each of the GMPEs used are shown below.



The contribution of each fault source was also provided in the program output, with the results listed in the table below:

Source	Region	Magnitude		Distance (km)		Contribution (%)
		Mode	Mean	Mode	Mean	
Wasatch fault, Weber section [2351e]	USGS 2014 Utah	7.15	7.03	1.25	1.25	69.49
Salt Lake City - Wasatch Fault Source Model	USGS 2014 Utah	6.95	6.92	13.75	15.41	17.01
Shallow - Extensional Gridded	USGS 2014 WUS Gridded Source	6.45	6.27	6.25	12.33	10.48
CEUS Gridded Source	USGS 2014 CEUS Gridded Source	5.05	5.68	13.75	28.84	0.97
Morgan fault [2353abc]	USGS 2014 Utah	6.55	6.54	11.25	13.36	0.78
Wasatch fault, Brigham City section [2351d]	USGS 2014 Utah	7.05	7.02	36.25	36.30	0.29
Great Salt Lake fault zone, Antelope Island [2369c]	USGS 2014 Utah	6.95	6.92	31.25	30.50	0.18
W50G50 West Valley (Wasatch 50) fault (dip 50)	USGS 2014 Utah	6.55	6.56	21.25	20.95	0.17
West Valley fault [2386]	USGS 2014 Utah	6.55	6.56	21.25	20.38	0.16
W50G35 West Valley (Wasatch 50) fault (dip 35)	USGS 2014 Utah	6.55	6.56	18.75	19.64	0.08
W65G50 West Valley (Wasatch 65) fault (dip 50)	USGS 2014 Utah	6.55	6.56	21.25	20.82	0.07
Great Salt Lake fault zone, Fremont Island s [2369b]	USGS 2014 Utah	6.85	6.89	33.75	34.26	0.06
W35G50 West Valley (Wasatch 35) fault (dip 50)	USGS 2014 Utah	6.65	6.57	21.25	21.33	0.05
W50G65 West Valley (Wasatch 50) fault (dip 65)	USGS 2014 Utah	6.65	6.57	21.25	22.46	0.04

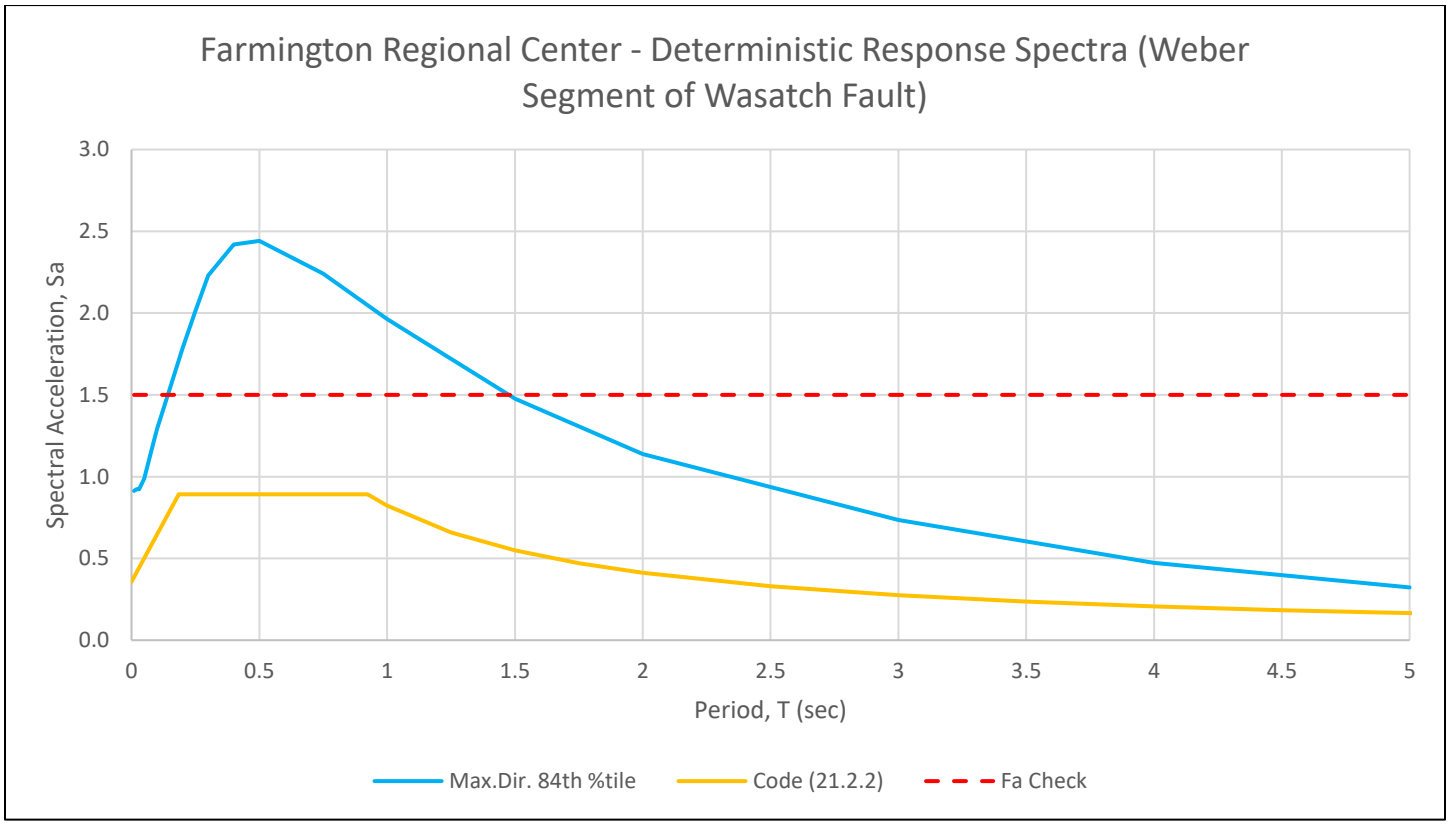
Source	Region	Magnitude		Distance (km)		Contribution (%)
		Mode	Mean	Mode	Mean	
West Cache fault, Wellsville section [2521c] USGS 2014 Utah	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
W65G35 West Valley (Wasatch 65) fault (dip 35)	USGS 2014 Utah	6.55	6.56	18.75	19.23	0.03
West Cache fault, Wellsville section [2521c] USGS 2014 Utah	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
W35G35 West Valley (Wasatch 35) fault (dip 35)	USGS 2014 Utah	6.55	6.56	21.25	20.22	0.02
West Cache fault, Wellsville section [2521c] USGS 2014 Utah	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
Stansbury fault zone [2395]	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
W35G65 West Valley (Wasatch 35) fault (dip 65)	USGS 2014 Utah	6.65	6.57	21.25	22.47	0.01
West Cache fault, Wellsville section [2521c] USGS 2014 Utah	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
West Cache fault, Wellsville section [2521c] USGS 2014 Utah	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
Stansbury fault zone [2395]	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
Bear River fault zone [730]	USGS 2014 Wyoming	N/A	N/A	N/A	N/A	0.00
West Cache fault zone, Junction Hills fault [2521b]	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
Hansel Valley fault [2358]	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
Eastern Bear Lake fault [2364abc]	USGS 2014 Idaho	N/A	N/A	N/A	N/A	0.00
North Promontory fault [2361]	USGS 2014 Nevada	N/A	N/A	N/A	N/A	0.00
Strawberry fault [2412]	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
Wasatch fault, Nephi section [2351h]	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
West Cache fault, Clarkston section [2521a]	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
Rock Creek fault [729]	USGS 2014 Wyoming	N/A	N/A	N/A	N/A	0.00
Wasatch fault, Levan section [2351i]	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
Joes Valley fault zone [2455]	USGS 2014 Utah	N/A	N/A	N/A	N/A	0.00
Grand Valley fault [726c]	USGS 2014 Wyoming	N/A	N/A	N/A	N/A	0.00
Greys River fault [728]	USGS 2014 Wyoming	N/A	N/A	N/A	N/A	0.00

As indicated in the above table, the DSHA is controlled (approximately 69% contribution) by potential rupture of the Weber segment of the Wasatch fault zone. The surface projection of the main trace of this fault zone is located approximately 1.0 kilometers northeast of the site. Since this fault dips to the west, the site is located on the hanging-wall side of the fault, and the closest orthogonal distance to the potential rupture surface is about 0.74 kilometers (see first table above).

EZFRISK considers three fault rupture scenarios for the Wasatch fault: full segment rupture, partial segment rupture, and rupture of the entire length of the fault. For deterministic ground motions, the largest characteristic (moment) magnitude is 7.4 for rupture of the entire ±357-kilometer length of the Wasatch fault, where all segments rupture simultaneously. However, the paleoseismic data suggests the various segments of the Wasatch fault have ruptured somewhat independently[11]. Accordingly, it is our opinion this highly unlikely fault rupture scenario should not be included for estimation of deterministic ground motions, but should instead be divided into individual fault segments. Accordingly, we used specific parameters from the Weber segment

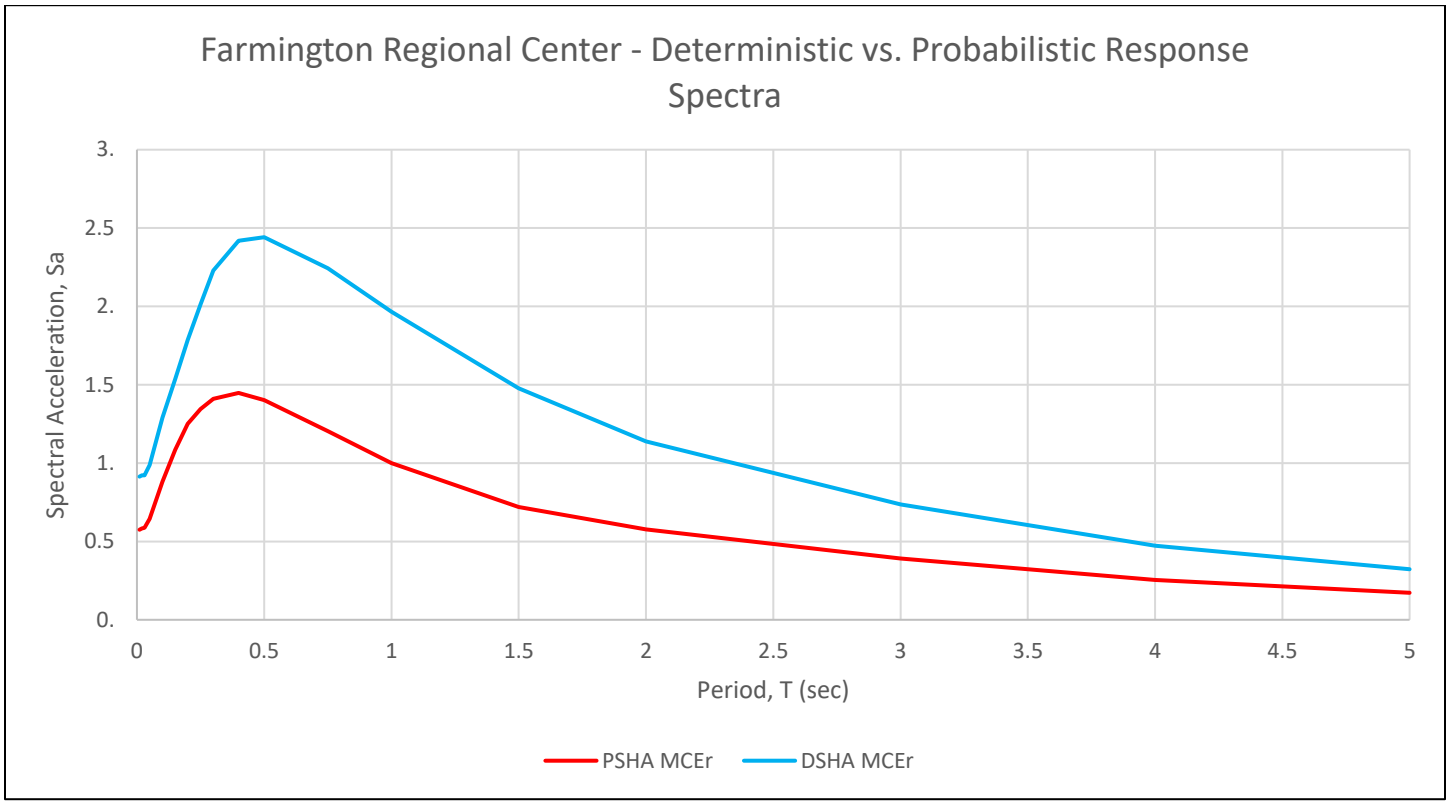
[11] https://earthquake.usgs.gov/cfusion/qfault/show_report_AB_archive.cfm?fault_id=2351&section_id=f

of the Wasatch fault as input into the NGA West2 worksheet/spreadsheet tool to obtain RotD50 (geometric mean) deterministic spectral values (see ***GMHA Summary*** in ***Appendix B***). ASCE 7-16 Section 21.2 requires that maximum accelerations in the horizontal plane (RotD100) be used for the spectral response. Section 21.2 also provides default directivity scaling factors, but allows the use of other appropriate scaling factors. For our analysis, we used the scaling factors presented by Shahi and Baker[10] (referenced above in **Section 3.2**) to obtain the corrected (RotD100) spectral values for the mean spectrum shown above (in black). These results are shown below, along with the code-based values. We also note that the maximum spectral accelerations exceeded the required minimum value of 1.5 times Fa (Fa=1.0 from OSHPD website), or 1.50, and thus do not need to be adjusted. ASCE 7-16 dictates that the maximum 84th percentile deterministic spectrum should not be lower than the code-based ordinate values, as defined in ASCE 7-16 Supplement 1 of Section 21.2.2. Accordingly, we compared the site-specific maximum 84th percentile deterministic spectra to the code-based values for the site, as shown below, which indicates that those spectral values are not less than the code-based spectrum and, thus, also do not need to be adjusted.

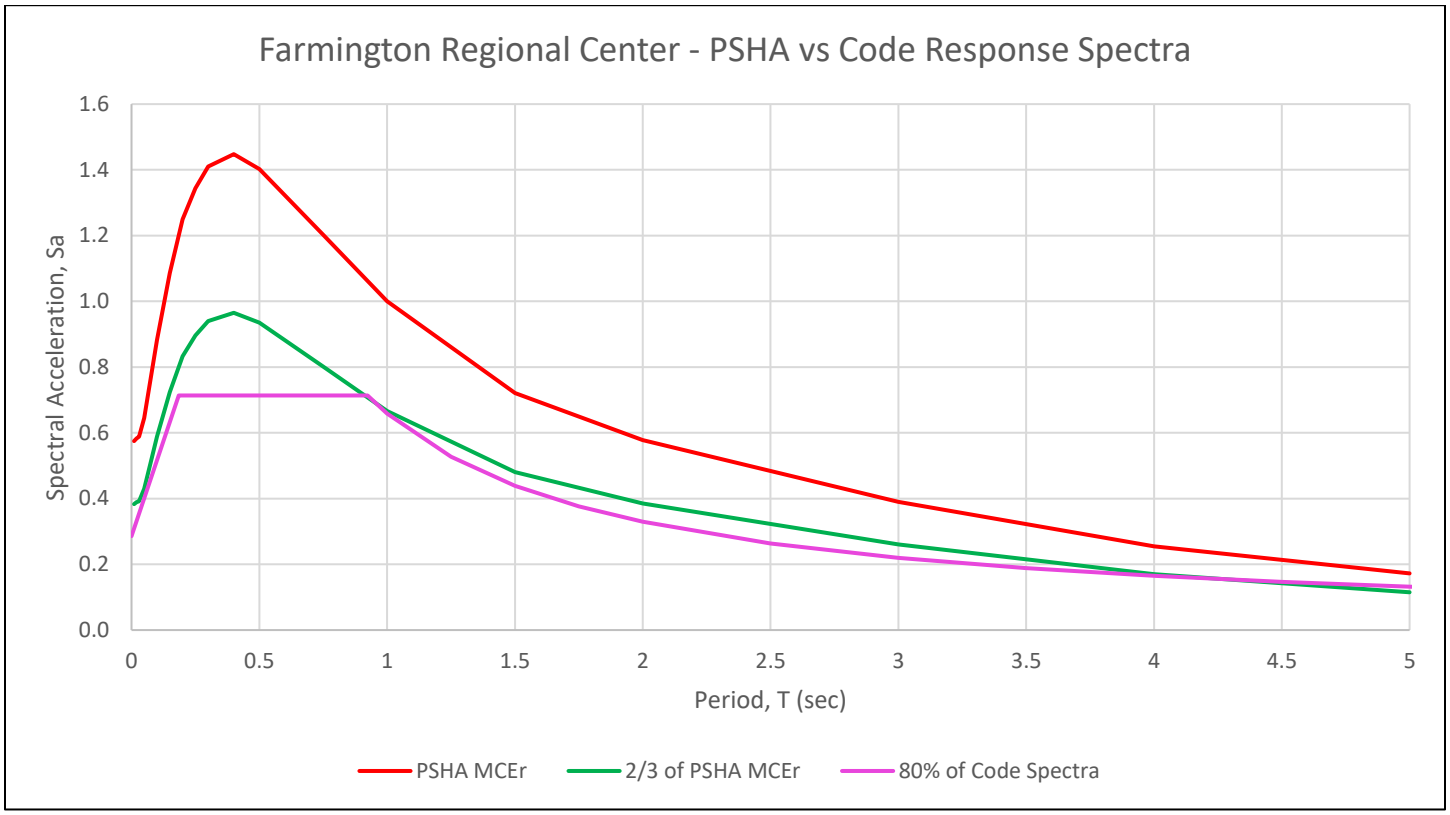


3.4 Site-Specific Seismic Design Parameters

The site-specific MCE_R spectral response acceleration is typically taken as the lesser of the PSHA and DSHA spectral response accelerations. As shown in the graph below, the probabilistic spectral response is lower than the deterministic spectral response. Accordingly, we recommend using the PSHA spectrum for the final design spectrum at this site.



We developed the final MCE_R response spectrum by comparing two-thirds of the PSHA spectral acceleration values with 80% of the code-based design spectrum as determined using the procedures of ASCE 7-16 Section 11.4.6 and the modified parameters in Section ASCE 7-16 Section 21.3. As required by ASCE 7-16 Section 21.3, this comparison (see below) shows that two-thirds of the mean PSHA site-specific design spectral accelerations are higher than the modified code-based design response accelerations for periods up to about 4.1 seconds, and lower than the modified code-based design response accelerations for periods beyond that. Therefore, the recommended site-specific horizontal design response spectrum is governed by the mean site-specific PSHA design response spectrum up to a period of about 4.1 seconds, and by the modified code-based response spectrum for periods greater than that.

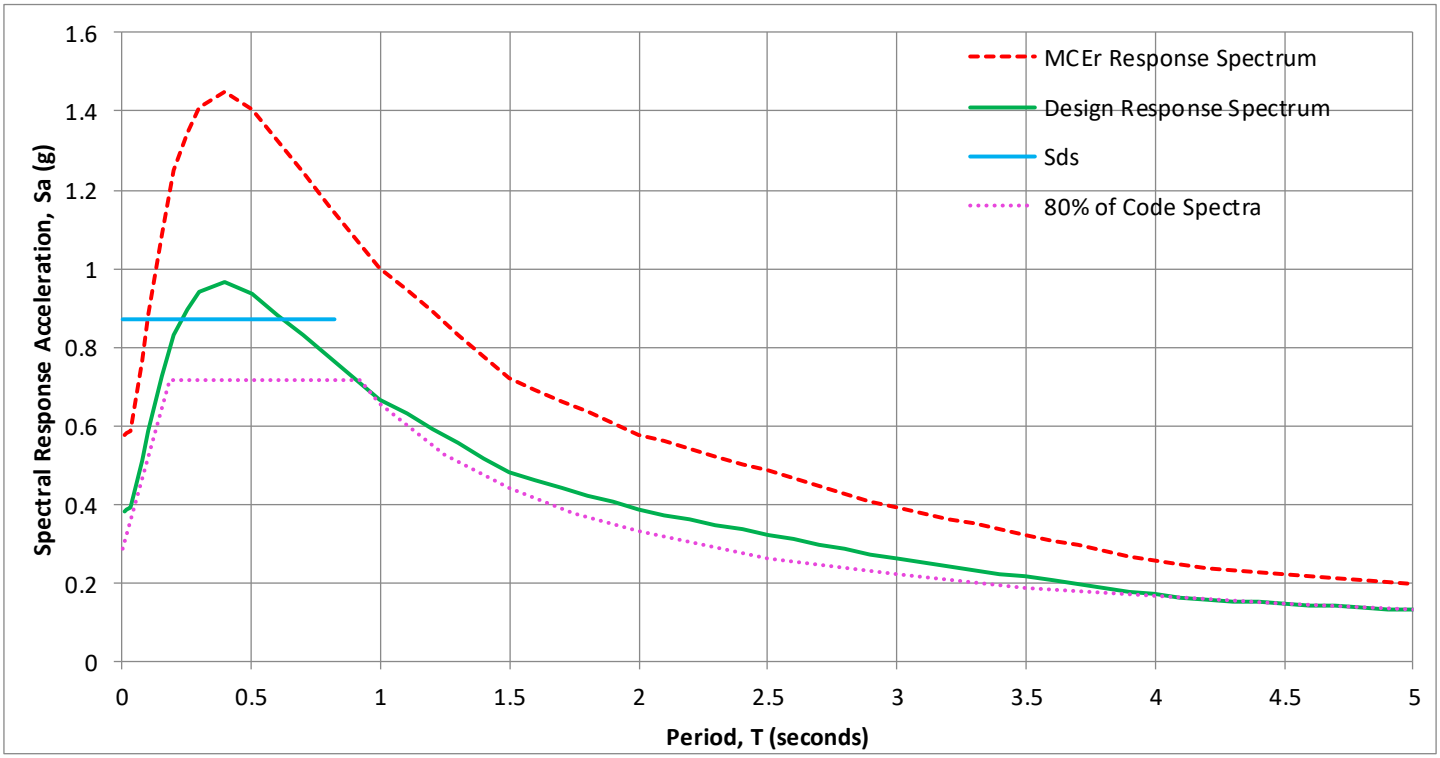


The short-period design spectral acceleration (S_{DS}) and 1-second period design spectral acceleration (S_{D1}) parameters were calculated in accordance with ASCE 7-16 Section 21.4. The parameter S_{DS} is 90% of the maximum design spectral acceleration between periods of 0.2 and 5 seconds, which resulted in 0.869. The parameter S_{D1} is the maximum value of the product of the period (T) and the spectral acceleration for periods from 1 to 5 seconds, which resulted in 0.807. The parameters S_{MS} and S_{M1} are 1.5 times S_{DS} and S_{D1}, respectively. The values of S_{MS}, S_{M1}, S_{DS}, and S_{D1} cannot be less than 80% of the values determined by ASCE 7-16 Sections 11.4.4 and 11.4.5, modified according to Section 21.3. For the subject site, the calculated values of S_{MS}, S_{DS}, S_{M1} and S_{D1} are greater than or equal to the minimum required values, thus we used the calculated values. These site-specific seismic design parameters and the design and MCE_R spectrum are shown below, as well as in **Section 1.4, Executive Summary**.

SPECTRAL ACCELERATION VALUE, T	SITE CLASS B/C BOUNDARY [mapped values] (g)	SITE CLASS D [GMHA Results] (g)	MULTIPLIER	DESIGN VALUES (g)
Peak Ground Acceleration	PGA_M = **0.735**	PGA_M = 0.575	1.000	PGA_M = 0.575
0.2 Seconds (Long Period Acceleration)	S_S = **1.338**	S_{MS} = 1.303	0.667	S_{DS} = 0.869
1.0 Second (Long Period Acceleration)	S_1 = **0.494**	S_{M1} = 1.210	0.667	S_{D1} = 0.807

NOTES: *** Site Class D With Data**

1. T_L (seconds): **8**
2. Site Class: **D**
3. Have data to verify? **Yes**



4.0 LIMITATIONS

The recommendations provided herein were developed by evaluating the information obtained from the subsurface explorations and soils encountered therein. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 590-0394. To schedule materials testing, please call (801) 381-5141.

APPENDIX A

EZ-FRISK DATA

```
                ********************************************
                *****              EZ-FRISK              *****
                ***** SEISMIC HAZARD ANALYSIS DEFINITION *****
                *****       FUGRO CONSULTANTS, INC.      *****
                *****        WALNUT CREEK, CA  USA       *****
                ********************************************

PROGRAM VERSION
  EZ-FRISK 8.07 Build 044

ANALYSIS TITLE:
  Farmington Regional Center

ANALYSIS TYPE:
  Single Site Analysis

SITE COORDINATES
  Latitude 40.9904
  Longitude -111.9

INTENSITY TYPE:  Spectral Response @ 5% Damping

HAZARD DEAGGREGATION
  Status: ON
  Deagregation Scenario 1
    Period:             PGA
    Amplitude:          0.5 Acceleration (g)
  Bin Configuration
    Magnitude
      Scale:         Moment Magnitude
      Lowest Value:  5 Mw
      Highest Value: 9 Mw
      Bin Size:      0.1
    Distance
      Lowest Value:  0 km
      Highest Value: 102.5 km
      Bin Size:      2.5 km
    Epsilon
      Lowest Value:  -2.2
      Highest Value: 4.2
      Bin Size:      0.2

SOIL AMPLIFICATION
  Method: Do not use soil amplification

ATTENUATION EQUATION SITE PARAMETERS
  Depth[Vs=1000m/s] (m): 400
  Estimate Z1 from Vs30 for CY NGA: 0
  Regional Code: Global
  Subduction Zone Setting: Unknown
  Vs30 (m/s): 237
  Vs30 Is Measured: 1
  Z25 (km): 2.65

AMPLITUDES - Acceleration (g)
  0.0001
  0.0005
  0.001
  0.005
  0.007
  0.01
  0.02
  0.05
  0.07
  0.1
  0.2
  0.3
  0.4
  0.5
  0.6
  0.7
  0.8
  1
  1.2
  1.5
  2
  3
  4
  5
  7
  10

PERIODS (s)
  PGA
  0.02
  0.03
  0.05
  0.075
  0.1
  0.15
```

0.2
0.25
0.3
0.4
0.5
0.75
1
1.5
2
3
4
5
7.5
10

DETERMINISTIC FRACTILES
0.84
Mean

PLOTTING PARAMETERS
Period at which to plot PGA: 0.01

CALCULATIONAL PARAMETERS
Fault Seismic Sources -
Maximum inclusion distance : 200 km
Down dip integration increment : 1 km
Horizontal integration increment : 1 km
Number rupture length per earthquake : 1
Subduction Interface Seismic Sources -
Maximum inclusion distance : 200 km
Down dip integration increment : 5 km
Horizontal integration increment : 20 km
Number rupture length per earthquake : 1
Subduction Slab Seismic Sources -
Maximum inclusion distance : 200 km
Down dip integration increment : 5 km
Horizontal integration increment : 20 km
Number rupture length per earthquake : 1
Area Seismic Sources -
Maximum inclusion distance : 200 km
Vertical integration increment : 3 km
Number of rupture azimuths : 3
Minimum epicentral distance step : 0.5 km
Maximum epicentral distance step : 10 km
Gridded Seismic Sources -
Maximum inclusion distance : 200 km
Default number of rupture azimuths : 20
Maximum distance for default azimuths : 40 km
Minimum distance for one azimuth : 150
Use binned calcuations if possible : true
Bins per decade in distance (km) : 20
All Seismic Sources -
Magnitude integration step : 0.1 M
Apply magnitude scaling : NO
Include near-source directivity : YES
Method : Bayless and Somerville (2013)
Component : RotD50
Hypocenter integration increment : 5 km

ATTENUATION EQUATIONS

Name: Abrahamson-et al (2014) NGA West 2 USGS 2014
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: Abrahamson-et al 2014 NGA West 2
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Distance To Rupture

Name: Atkinson (2008p) USGS 2014 Table Soil
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: Table
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Horizontal Distance To Rupture

Name: Atkinson-Boore (2006p) USGS 2014 Table Soil
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: Table
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Distance To Rupture

Name: Boore-et al (2014) NGA West 2 USGS 2014
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: Boore-et al 2014 NGA West 2
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3

Magnitude Scale: Moment Magnitude
Distance Type: Horizontal Distance To Rupture

Name: Campbell (2003) USGS 2008 Mw
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: NEHRP Soil Amplifier
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Distance To Rupture

Name: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: Campbell-Bozorgnia 2014 NGA West 2
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Distance To Rupture

Name: Chiou-Youngs (2014) NGA West 2 USGS 2014
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: Chiou-Youngs 2014 NGA West 2
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Distance To Rupture

Name: Frankel (1996) USGS 2008 Truncated Mw
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: NEHRP Soil Amplifier
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Distance To Rupture

Name: Pezeshk et al (2011) USGS 2014 Table Soil
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: Table
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Distance To Rupture

Name: Silva et al (2002) USGS 2008 Mw
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: NEHRP Soil Amplifier
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Horizontal Distance To Rupture

Name: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: Tavakoli and Pezeshk 2005
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Distance To Rupture

Name: Toro (1999) Midcontinent - USGS 2008 Mw
Database: C:\Program Files (x86)\EZ-FRISK 8.07\Files\standard.bin-attendb
Base: NEHRP Soil Amplifier
Truncation Type: USGS 2008 NSHM Truncation
Truncation Value: 3
Magnitude Scale: Moment Magnitude
Distance Type: Horizontal Distance To Rupture

SEISMIC SOURCE SUMMARY TABLE

Site Source	Region	Closest Distance	Deterministic Magnitude	Fault Mechanism	Dip Angle	Dips To
CEUS Gridded Source	USGS 2014 CEUS Gridded Source	0.00	0.0000	Strike Slip	90.0000	--
Shallow - Extensional Gridded	USGS 2014 WUS Gridded Source	0.00	8.0000	N|SS	90.0000	--
Wasatch fault, Weber section [2351e]	USGS 2014 Utah	0.74	7.1600	Normal	35-65	W
Salt Lake City - Wasatch Fault Source Model	USGS 2014 Utah	0.78	7.4010	N|SS	35-90	W
Morgan fault [2353abc]	USGS 2014 Utah	11.67	6.5200	Normal	35-65	W
West Valley fault [2386]	USGS 2014 Utah	18.84	6.5000	Normal	35-65	E
W65G35 West Valley (Wasatch 65) fault (dip 35)	USGS 2014 Utah	19.22	6.5000	Normal	35.0000	E
W50G35 West Valley (Wasatch 50) fault (dip 35)	USGS 2014 Utah	19.63	6.5000	Normal	35.0000	E

W35G35 West Valley (Wasatch 35) fault (dip 35)	USGS 2014 Utah	20.21	6.5000	Normal	35.0000 E N
W65G50 West Valley (Wasatch 65) fault (dip 50)	USGS 2014 Utah	20.81	6.5000	Normal	50.0000 E N
W50G50 West Valley (Wasatch 50) fault (dip 50)	USGS 2014 Utah	20.94	6.5000	Normal	50.0000 E N
W35G50 West Valley (Wasatch 35) fault (dip 50)	USGS 2014 Utah	21.32	6.5000	Normal	50.0000 E N
W50G65 West Valley (Wasatch 50) fault (dip 65)	USGS 2014 Utah	22.45	6.5000	Normal	65.0000 E N
W65G65 West Valley (Wasatch 65) fault (dip 65)	USGS 2014 Utah	22.45	6.5000	Normal	65.0000 E N
W35G65 West Valley (Wasatch 35) fault (dip 65)	USGS 2014 Utah	22.46	6.5000	Normal	65.0000 E N
Great Salt Lake fault zone, Antelope Island [2369c]	USGS 2014 Utah	30.45	6.9300	Normal	35-65 W NE
Great Salt Lake fault zone, Fremont Island s [2369b]	USGS 2014 Utah	34.02	6.8300	Normal	35-65 SW E
Wasatch fault, Brigham City section [2351d]	USGS 2014 Utah	34.90	6.9500	Normal	35-65 W SE
Oquirrh-Southern Oquirrh Mountains fault [2398_2399]	USGS 2014 Utah	44.31	7.1700	Normal	35-65 W NE
East Cache fault zone [2352abc]	USGS 2014 Utah	48.95	7.3100	Normal	35-65 W S
Great Salt Lake fault zone, Promontory secti [2369a]	USGS 2014 Utah	51.84	7.0900	Normal	35-65 SW SE
Wasatch fault, Provo section [2351g]	USGS 2014 Utah	55.45	7.2700	Normal	35-65 W N
West Cache fault, Wellsville section [2521c]	USGS 2014 Utah	65.52	6.6000	Normal	35-65 NE S
Stansbury fault zone [2395]	USGS 2014 Utah	72.10	7.0900	Normal	35-65 W NE
Bear River fault zone [730]	USGS 2014 Wyoming	72.47	6.9000	Normal	35-65 W W
West Cache fault zone, Junction Hills fault [2521b]	USGS 2014 Utah	78.30	6.7000	Normal	35-65 NE S
Hansel Valley fault [2358]	USGS 2014 Utah	89.85	6.6000	Normal	35-65 E SE
Eastern Bear Lake fault [2364abc]	USGS 2014 Idaho	91.38	7.2900	Normal	35-65 W S
North Promontory fault [2361]	USGS 2014 Nevada	96.70	6.7300	Normal	35-65 W SE
Strawberry fault [2412]	USGS 2014 Utah	97.07	6.9200	Normal	35-65 W NW
Wasatch fault, Nephi section [2351h]	USGS 2014 Utah	100.23	7.0100	Normal	35-65 W N
West Cache fault, Clarkston section [2521a]	USGS 2014 Utah	101.62	6.6600	Normal	35-65 E S
Rock Creek fault [729]	USGS 2014 Wyoming	116.95	6.9500	Normal	35-65 W SW
Wasatch fault, Levan section [2351i]	USGS 2014 Utah	149.83	6.8300	Normal	35-65 W N
Joes Valley fault zone [2455]	USGS 2014 Utah	160.39	7.0200	Normal	35-65 W N
Grand Valley fault [726c]	USGS 2014 Wyoming	182.60	7.1000	Normal	35-65 W S
Greys River fault [728]	USGS 2014 Wyoming	193.01	7.0500	Normal	35-65 W SW

SEISMIC SOURCES

Name: CEUS Gridded Source
Region: USGS 2014 CEUS Gridded Source
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
 ------ Start Nested Sources forCEUS Gridded Source -------
Name: CEUS_adGridded_2014_2zone_Mmax 6.5-6.8
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.2
  Latitude Increment, degrees: 0.1
  Longitude Increment, degrees: 0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters	(Varies point to point?)
Cell Weight: 1	Yes
Fault Mechanism: Strike Slip	
Depth to Top of Rupture, km: 5	
Minimum Magnitude: 4.7	
Maximum Magnitude: 0	Yes
Rate at Minimum Magnitude, events per year: 0	Yes
Beta: 2.3025	
Horizontal Rupture Length, A parameter: -2.0325	
Horizontal Rupture Length, B parameter: 0.5	

```
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_adGridded_2014_2zone_Mmax 7.0-7.2
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.2
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                 Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                           Yes
  Rate at Minimum Magnitude, events per year: 0  Yes
  Beta: 2.3025
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_adGridded_2014_2zone_Mmax 7.5-7.6
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.2
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                 Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                           Yes
  Rate at Minimum Magnitude, events per year: 0  Yes
  Beta: 2.3025
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_adGridded_2014_2zone_Mmax 8.0
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.2
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                 Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                           Yes
  Rate at Minimum Magnitude, events per year: 0  Yes
  Beta: 2.3025
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_adGridded_2014_4zone_Mmax 6.5-6.8
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.2
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                 Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
```

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  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                              Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.3025
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_adGridded_2014_4zone_Mmax 7.0-7.2
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.2
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                  Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                              Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.3025
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_adGridded_2014_4zone_Mmax 7.5-7.6
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.2
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                  Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                              Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.3025
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_adGridded_2014_4zone_Mmax 8.0
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.2
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                  Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                              Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.3025
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_fixGridded_2014_2zone_Mmax 6.5-6.8
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.3
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
```

```
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                  Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.3025                                    Yes
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_fixGridded_2014_2zone_Mmax 7.0-7.2
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.3
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                  Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.3025                                    Yes
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_fixGridded_2014_2zone_Mmax 7.5-7.6
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.3
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                  Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.3025                                    Yes
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_fixGridded_2014_2zone_Mmax 8.0
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.3
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                  Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.3025                                    Yes
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_fixGridded_2014_4zone_Mmax 6.5-6.8
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008
```

```
General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.3
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                 Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                           Yes
  Rate at Minimum Magnitude, events per year: 0  Yes
  Beta: 2.3025                                   Yes
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_fixGridded_2014_4zone_Mmax 7.0-7.2
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.3
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                 Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                           Yes
  Rate at Minimum Magnitude, events per year: 0  Yes
  Beta: 2.3025                                   Yes
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_fixGridded_2014_4zone_Mmax 7.5-7.6
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.3
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                 Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                           Yes
  Rate at Minimum Magnitude, events per year: 0  Yes
  Beta: 2.3025                                   Yes
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS_fixGridded_2014_4zone_Mmax 8.0
Region: USGS 2014 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.3
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 4.7

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1                                 Yes
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 4.7
  Maximum Magnitude: 0                           Yes
  Rate at Minimum Magnitude, events per year: 0  Yes
  Beta: 2.3025                                   Yes
  Horizontal Rupture Length, A parameter: -2.0325
  Horizontal Rupture Length, B parameter: 0.5
```

```
  Rupture Strike Azimuth Model: Random Strike

 ------ End Nested Sources for CEUS Gridded Source -------

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
      0.06      0.060000          Frankel (1996) USGS 2008 Truncated Mw
      0.13      0.130000          Toro (1999) Midcontinent - USGS 2008 Mw
      0.06      0.060000          Silva et al (2002) USGS 2008 Mw
      0.13      0.130000          Campbell (2003) USGS 2008 Mw
      0.13      0.130000          Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
      0.25      0.250000          Atkinson-Boore (2006p) USGS 2014 Table Soil
      0.16      0.160000          Pezeshk et al (2011) USGS 2014 Table Soil
      0.08      0.080000          Atkinson (2008p) USGS 2014 Table Soil

****************************************

Name: Shallow - Extensional Gridded
Region: USGS 2014 WUS Gridded Source
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
 ------ Start Nested Sources forShallow - Extensional Gridded -------
Name: Extensional Gridded, adSm, Tapered_M7.95, Strike Slip
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.0133333
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 8
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, adSm, Tapered_M7.95, Normal
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.0266667
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Normal
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 8
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, adSm, Truncated_M7.5, Char, Normal
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.16
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Normal
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                          Yes
```

```
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, adSm, Truncated_M7.5, Char, Strike Slip
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.08
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, adSm, Truncated_M7.5, GR, Normal
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.08
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Normal
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, adSm, Truncated_M7.5, GR, Strike Slip
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.04
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, fixSm, Tapered_M7.95, Normal
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.04
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5
```

```
Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Normal
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 8
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, fixSm, Tapered_M7.95, Strike Slip
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.02
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 8
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, fixSm, Truncated_M7.5, Char, Normal
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.24
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Normal
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, fixSm, Truncated_M7.5, Char, Strike Slip
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.12
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, fixSm, Truncated_M7.5, GR, Normal
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
```

```
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.12
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Normal
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: Extensional Gridded, fixSm, Truncated_M7.5, GR, Strike Slip
Region: USGS 2014 Western US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: Moment Magnitude
  Probability of Activity: 0.06
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 1.842
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

 ------ End Nested Sources for Shallow - Extensional Gridded -------

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
      0.25      0.250000          Abrahamson-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Boore-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

*****************************************

Name: Wasatch fault, Weber section [2351e]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
 ------ Start Nested Sources forWasatch fault, Weber section [2351e] -------
Name: 2351e Wasatch fault, Weber section (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 7.16

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        35         0     0.001        15

Magnitude Recurrence Distributions:
       ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
          Normal 0.0160008    Activity  7.157e-004  6.710000  7.190000  2.300000  6.950000  0.120000  0.010000 10.000000
          Normal  0.048002    Activity  7.157e-004  6.910000  7.390000  2.300000  7.150000  0.120000  0.010000 10.000000
          Normal  0.016001    Activity  7.157e-004  7.110000  7.590000  2.300000  7.350000  0.120000  0.010000 10.000000
     Exponential  0.004000    Activity  1.937e-003  6.500000  6.950000  1.842068  0.000000  0.000000  0.000000  0.000000
     Exponential  0.011999    Activity  2.399e-003  6.500000  7.150000  1.842068  0.000000  0.000000  0.000000  0.000000
     Exponential  0.004000    Activity  2.719e-003  6.500000  7.350000  1.842068  0.000000  0.000000  0.000000  0.000000
          Normal  0.127999    Activity  7.157e-004  6.720000  7.200000  2.300000  6.960000  0.120000  0.010000 10.000000
          Normal  0.383997    Activity  7.157e-004  6.920000  7.400000  2.300000  7.160000  0.120000  0.010000 10.000000
          Normal  0.127999    Activity  7.157e-004  7.120000  7.600000  2.300000  7.360000  0.120000  0.010000 10.000000
     Exponential  0.032000    Activity  1.983e-003  6.500000  6.960000  1.842068  0.000000  0.000000  0.000000  0.000000
     Exponential  0.096001    Activity  2.441e-003  6.500000  7.160000  1.842068  0.000000  0.000000  0.000000  0.000000
     Exponential  0.032000    Activity  2.758e-003  6.500000  7.360000  1.842068  0.000000  0.000000  0.000000  0.000000
          Normal  0.016001    Activity  7.157e-004  6.710000  7.190000  2.300000  6.950000  0.120000  0.010000 10.000000
          Normal  0.048002    Activity  7.157e-004  6.910000  7.390000  2.300000  7.150000  0.120000  0.010000 10.000000
          Normal  0.016001    Activity  7.157e-004  7.110000  7.590000  2.300000  7.350000  0.120000  0.010000 10.000000
     Exponential  0.004000    Activity  1.937e-003  6.500000  6.950000  1.842068  0.000000  0.000000  0.000000  0.000000
```

Exponential	0.011999	Activity	2.399e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	2.719e-003	6.500000	7.350000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.3333	-111.9614
41.3068	-111.9307
41.2949	-111.9419
41.2772	-111.9491
41.2628	-111.9472
41.2598	-111.9398
41.2501	-111.9383
41.2406	-111.9277
41.2228	-111.9296
41.2148	-111.9242
41.2085	-111.9329
41.1868	-111.9396
41.1796	-111.9370
41.1767	-111.9290
41.1646	-111.9248
41.1509	-111.9069
41.1427	-111.9083
41.1314	-111.8983
41.1037	-111.9108
41.0852	-111.9044
41.0680	-111.9107
41.0556	-111.9039
41.0392	-111.9073
41.0291	-111.8997
41.0045	-111.8959
40.9992	-111.8852
40.9917	-111.8855
40.9770	-111.8747
40.9637	-111.8721
40.9608	-111.8795
40.9545	-111.8810
40.9460	-111.8743
40.9048	-111.8653
40.8905	-111.8526
40.8661	-111.8568
40.8494	-111.8870

Name: 2351e Wasatch fault, Weber section (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.54000108
Deterministic Magnitude: 7.16

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	7.157e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	7.157e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.110000	7.590000	2.300000	7.350000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.937e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.399e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	2.719e-003	6.500000	7.350000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	7.157e-004	6.720000	7.200000	2.300000	6.960000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	7.157e-004	6.920000	7.400000	2.300000	7.160000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	7.157e-004	7.120000	7.600000	2.300000	7.360000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	1.983e-003	6.500000	6.960000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	2.441e-003	6.500000	7.160000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	2.758e-003	6.500000	7.360000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	7.157e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000

Normal	0.048002	Activity	7.157e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.110000	7.590000	2.300000	7.350000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.937e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.399e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	2.719e-003	6.500000	7.350000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.3333	-111.9614
41.3068	-111.9307
41.2949	-111.9419
41.2772	-111.9491
41.2628	-111.9472
41.2598	-111.9398
41.2501	-111.9383
41.2406	-111.9277
41.2228	-111.9296
41.2148	-111.9242
41.2085	-111.9329
41.1868	-111.9396
41.1796	-111.9370
41.1767	-111.9290
41.1646	-111.9248
41.1509	-111.9069
41.1427	-111.9083
41.1314	-111.8983
41.1037	-111.9108
41.0852	-111.9044
41.0680	-111.9107
41.0556	-111.9039
41.0392	-111.9073
41.0291	-111.8997
41.0045	-111.8959
40.9992	-111.8852
40.9917	-111.8855
40.9770	-111.8747
40.9637	-111.8721
40.9608	-111.8795
40.9545	-111.8810
40.9460	-111.8743
40.9048	-111.8653
40.8905	-111.8526
40.8661	-111.8568
40.8494	-111.8870

Name: 2351e Wasatch fault, Weber section (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 7.16

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	7.157e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	7.157e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.110000	7.590000	2.300000	7.350000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.937e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.399e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	2.719e-003	6.500000	7.350000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	7.157e-004	6.720000	7.200000	2.300000	6.960000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	7.157e-004	6.920000	7.400000	2.300000	7.160000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	7.157e-004	7.120000	7.600000	2.300000	7.360000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	1.983e-003	6.500000	6.960000	1.842068	0.000000	0.000000	0.000000	0.000000

Exponential	0.096001	Activity	2.441e-003	6.500000	7.160000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	2.758e-003	6.500000	7.360000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	7.157e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	7.157e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.110000	7.590000	2.300000	7.350000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.937e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.399e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	2.719e-003	6.500000	7.350000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.3333	-111.9614
41.3068	-111.9307
41.2949	-111.9419
41.2772	-111.9491
41.2628	-111.9472
41.2598	-111.9398
41.2501	-111.9383
41.2406	-111.9277
41.2228	-111.9296
41.2148	-111.9242
41.2085	-111.9329
41.1868	-111.9396
41.1796	-111.9370
41.1767	-111.9290
41.1646	-111.9248
41.1509	-111.9069
41.1427	-111.9083
41.1314	-111.8983
41.1037	-111.9108
41.0852	-111.9044
41.0680	-111.9107
41.0556	-111.9039
41.0392	-111.9073
41.0291	-111.8997
41.0045	-111.8959
40.9992	-111.8852
40.9917	-111.8855
40.9770	-111.8747
40.9637	-111.8721
40.9608	-111.8795
40.9545	-111.8810
40.9460	-111.8743
40.9048	-111.8653
40.8905	-111.8526
40.8661	-111.8568
40.8494	-111.8870

------ End Nested Sources for Wasatch fault, Weber section [2351e] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Salt Lake City - Wasatch Fault Source Model
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forSalt Lake City - Wasatch Fault Source Model -------
Name: 2351f Wasatch fault, Salt Lake City section - Partial GR (dip 35)
Region: USGS 2014
Category:Fault

Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.02401200
Deterministic Magnitude: 7.03

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Exponential	0.2	Activity	1.418e-003	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.600000	Activity	1.941e-003	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.200000	Activity	2.302e-003	6.500000	7.230000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.7813	-111.8928
40.7687	-111.8922
40.7560	-111.8641
40.7473	-111.8579
40.7372	-111.8549
40.7307	-111.8606
40.7121	-111.8632
40.6816	-111.8417
40.6727	-111.8335
40.6737	-111.8082
40.6519	-111.8095
40.6308	-111.7997
40.6169	-111.7878
40.6047	-111.7942
40.5901	-111.7895
40.5811	-111.7961
40.5638	-111.7947
40.5490	-111.8014
40.5286	-111.8266
40.5130	-111.8391
40.5006	-111.8367
40.4950	-111.8217

Name: 2351f Wasatch fault, Salt Lake City section - Partial GR (dip 50)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.03601800
Deterministic Magnitude: 7.03

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Exponential	0.2	Activity	1.418e-003	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.600000	Activity	1.941e-003	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.200000	Activity	2.302e-003	6.500000	7.230000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.7813	-111.8928
40.7687	-111.8922
40.7560	-111.8641
40.7473	-111.8579
40.7372	-111.8549
40.7307	-111.8606
40.7121	-111.8632
40.6816	-111.8417
40.6727	-111.8335
40.6737	-111.8082

40.6519	-111.8095
40.6308	-111.7997
40.6169	-111.7878
40.6047	-111.7942
40.5901	-111.7895
40.5811	-111.7961
40.5638	-111.7947
40.5490	-111.8014
40.5286	-111.8266
40.5130	-111.8391
40.5006	-111.8367
40.4950	-111.8217

Name: 2351f Wasatch fault, Salt Lake City section - Partial GR (dip 65)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.01200600
Deterministic Magnitude: 7.03

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Exponential	0.2	Activity	1.418e-003	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.600000	Activity	1.941e-003	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.200000	Activity	2.302e-003	6.500000	7.230000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.7813	-111.8928
40.7687	-111.8922
40.7560	-111.8641
40.7473	-111.8579
40.7372	-111.8549
40.7307	-111.8606
40.7121	-111.8632
40.6816	-111.8417
40.6727	-111.8335
40.6737	-111.8082
40.6519	-111.8095
40.6308	-111.7997
40.6169	-111.7878
40.6047	-111.7942
40.5901	-111.7895
40.5811	-111.7961
40.5638	-111.7947
40.5490	-111.8014
40.5286	-111.8266
40.5130	-111.8391
40.5006	-111.8367
40.4950	-111.8217

Name: 2351f Wasatch Fault SLC Pechmann (dip 35)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.04800000
Deterministic Magnitude: 7.07

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	7.690e-004	6.630000	7.110000	0.000000	6.870000	0.120000	0.000000	0.000000
Normal	0.600000	Activity	7.690e-004	6.830000	7.310000	0.000000	7.070000	0.120000	0.000000	0.000000
Normal	0.200000	Activity	7.690e-004	7.030000	7.510000	0.000000	7.270000	0.120000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.8091	-111.9129
40.7927	-111.9003
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7796	-111.8906
40.7785	-111.8903
40.7777	-111.8902
40.7769	-111.8900
40.7761	-111.8898
40.7755	-111.8897
40.7748	-111.8897
40.7741	-111.8897
40.7734	-111.8898
40.7724	-111.8901
40.7716	-111.8903
40.7710	-111.8906
40.7704	-111.8908
40.7700	-111.8908
40.7689	-111.8913
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7706	-111.8476
40.7697	-111.8488
40.7691	-111.8498
40.7683	-111.8505
40.7677	-111.8515
40.7670	-111.8527
40.7660	-111.8546
40.7651	-111.8564
40.7642	-111.8577
40.7633	-111.8589
40.7627	-111.8596
40.7618	-111.8609
40.7608	-111.8619
40.7600	-111.8628
40.7588	-111.8634
40.7576	-111.8637
40.7566	-111.8636
40.7557	-111.8634
40.7547	-111.8629
40.7539	-111.8623
40.7530	-111.8618
40.7521	-111.8608
40.7514	-111.8601
40.7507	-111.8595
40.7501	-111.8590
40.7477	-111.8574
40.7456	-111.8569
40.7443	-111.8564
40.7430	-111.8559
40.7414	-111.8548
40.7396	-111.8546
40.7373	-111.8546
40.7354	-111.8556
40.7339	-111.8574
40.7326	-111.8587
40.7318	-111.8598
40.7302	-111.8603
40.7287	-111.8598
40.7268	-111.8598
40.7250	-111.8601
40.7232	-111.8601
40.7211	-111.8601
40.7189	-111.8602
40.7172	-111.8611
40.7156	-111.8619
40.7142	-111.8624
40.7129	-111.8624
40.7113	-111.8621
40.7103	-111.8614
40.7095	-111.8607
40.7082	-111.8595
40.7072	-111.8584
40.7060	-111.8574
40.7046	-111.8564
40.7035	-111.8555
40.7022	-111.8538
40.7007	-111.8522
40.6986	-111.8512
40.6966	-111.8509
40.6945	-111.8488

40.6927 -111.8475
40.6908 -111.8457
40.6890 -111.8452
40.6864 -111.8441
40.6864 -111.8431
40.6833 -111.8418
40.6814 -111.8407
40.6799 -111.8394
40.6788 -111.8381
40.6778 -111.8368
40.6770 -111.8360
40.6754 -111.8353
40.6739 -111.8342
40.6726 -111.8315
40.6718 -111.8291
40.6710 -111.8265
40.6705 -111.8241
40.6697 -111.8218
40.6692 -111.8200
40.6687 -111.8179
40.6682 -111.8158
40.6676 -111.8137
40.6671 -111.8119
40.6666 -111.8103
40.6661 -111.8093
40.6658 -111.8077
40.6658 -111.8072
40.6635 -111.8067
40.6619 -111.8064
40.6606 -111.8064
40.6588 -111.8067
40.6572 -111.8072
40.6554 -111.8075
40.6543 -111.8082
40.6538 -111.8085
40.6523 -111.8085
40.6504 -111.8085
40.6486 -111.8069
40.6478 -111.8059
40.6473 -111.8048
40.6455 -111.8035
40.6436 -111.8022
40.6413 -111.8007
40.6397 -111.7994
40.6387 -111.7986
40.6358 -111.7994
40.6340 -111.7996
40.6319 -111.7991
40.6298 -111.7978
40.6285 -111.7965
40.6267 -111.7954
40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7908
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
40.6100 -111.7905
40.6082 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
40.5990 -111.7936
40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
40.5894 -111.7889
40.5873 -111.7902
40.5857 -111.7918
40.5834 -111.7934
40.5821 -111.7949
40.5791 -111.7953
40.5766 -111.7953
40.5750 -111.7956
40.5730 -111.7956
40.5712 -111.7959
40.5696 -111.7959
40.5681 -111.7951
40.5660 -111.7943
40.5642 -111.7943
40.5624 -111.7948
40.5609 -111.7977
40.5593 -111.7982

40.5578	-111.7982
40.5562	-111.7994
40.5544	-111.7994
40.5526	-111.7997
40.5511	-111.8007
40.5482	-111.8020
40.5467	-111.8038
40.5446	-111.8061
40.5433	-111.8077
40.5423	-111.8092
40.5413	-111.8108
40.5390	-111.8123
40.5372	-111.8136
40.5354	-111.8149
40.5328	-111.8190
40.5310	-111.8211
40.5300	-111.8242
40.5279	-111.8265
40.5248	-111.8291
40.5225	-111.8316
40.5207	-111.8337
40.5184	-111.8355
40.5166	-111.8365
40.5143	-111.8378
40.5122	-111.8391
40.5094	-111.8388
40.5071	-111.8388
40.5047	-111.8381
40.5027	-111.8373
40.5011	-111.8363
40.5001	-111.8352
40.4985	-111.8336

Name: 2351f Wasatch Fault SLC Pechmann (dip 50)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.14400000
Deterministic Magnitude: 7.07

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	7.690e-004	6.630000	7.110000	0.000000	6.870000	0.120000	0.000000	0.000000
Normal	0.600000	Activity	7.690e-004	6.830000	7.310000	0.000000	7.070000	0.120000	0.000000	0.000000
Normal	0.200000	Activity	7.690e-004	7.030000	7.510000	0.000000	7.270000	0.120000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.8091	-111.9129
40.7927	-111.9003
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7796	-111.8906
40.7785	-111.8903
40.7777	-111.8902
40.7769	-111.8900
40.7761	-111.8898
40.7755	-111.8897
40.7748	-111.8897
40.7741	-111.8897
40.7734	-111.8898
40.7724	-111.8901
40.7716	-111.8903
40.7710	-111.8906
40.7704	-111.8908
40.7700	-111.8908
40.7689	-111.8913
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7706	-111.8476
40.7697	-111.8488
40.7691	-111.8498

40.7683 -111.8505
40.7677 -111.8515
40.7670 -111.8527
40.7660 -111.8546
40.7651 -111.8564
40.7642 -111.8577
40.7633 -111.8589
40.7627 -111.8596
40.7618 -111.8609
40.7608 -111.8619
40.7600 -111.8628
40.7588 -111.8634
40.7576 -111.8637
40.7566 -111.8636
40.7557 -111.8634
40.7547 -111.8629
40.7539 -111.8623
40.7530 -111.8618
40.7521 -111.8608
40.7514 -111.8601
40.7507 -111.8595
40.7501 -111.8590
40.7477 -111.8574
40.7456 -111.8569
40.7443 -111.8564
40.7430 -111.8559
40.7414 -111.8548
40.7396 -111.8546
40.7373 -111.8546
40.7354 -111.8556
40.7339 -111.8574
40.7326 -111.8587
40.7318 -111.8598
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40.7250 -111.8601
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40.7211 -111.8601
40.7189 -111.8602
40.7172 -111.8611
40.7156 -111.8619
40.7142 -111.8624
40.7129 -111.8624
40.7113 -111.8621
40.7103 -111.8614
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40.7082 -111.8595
40.7072 -111.8584
40.7060 -111.8574
40.7046 -111.8564
40.7035 -111.8555
40.7022 -111.8538
40.7007 -111.8522
40.6986 -111.8512
40.6966 -111.8509
40.6945 -111.8488
40.6927 -111.8475
40.6908 -111.8457
40.6890 -111.8452
40.6864 -111.8441
40.6864 -111.8431
40.6833 -111.8418
40.6814 -111.8407
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40.6754 -111.8353
40.6739 -111.8342
40.6726 -111.8315
40.6718 -111.8291
40.6710 -111.8265
40.6705 -111.8241
40.6697 -111.8218
40.6692 -111.8200
40.6687 -111.8179
40.6682 -111.8158
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40.6666 -111.8103
40.6661 -111.8093
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40.6619 -111.8064
40.6606 -111.8064
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40.6543 -111.8082
40.6538 -111.8085
40.6523 -111.8085
40.6504 -111.8085
40.6486 -111.8069
40.6478 -111.8059
40.6473 -111.8048
40.6455 -111.8035
40.6436 -111.8022
40.6413 -111.8007
40.6397 -111.7994
40.6387 -111.7986
40.6358 -111.7994
40.6340 -111.7996
40.6319 -111.7991
40.6298 -111.7978
40.6285 -111.7965
40.6267 -111.7954
40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7908
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
40.6100 -111.7905
40.6082 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
40.5990 -111.7936
40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
40.5894 -111.7889
40.5873 -111.7902
40.5857 -111.7918
40.5834 -111.7934
40.5821 -111.7949
40.5791 -111.7953
40.5766 -111.7953
40.5750 -111.7956
40.5730 -111.7956
40.5712 -111.7959
40.5696 -111.7959
40.5681 -111.7951
40.5660 -111.7943
40.5642 -111.7943
40.5624 -111.7948
40.5609 -111.7977
40.5593 -111.7982
40.5578 -111.7982
40.5562 -111.7994
40.5544 -111.7994
40.5526 -111.7997
40.5511 -111.8007
40.5482 -111.8020
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40.5446 -111.8061
40.5433 -111.8077
40.5423 -111.8092
40.5413 -111.8108
40.5390 -111.8123
40.5372 -111.8136
40.5354 -111.8149
40.5328 -111.8190
40.5310 -111.8211
40.5300 -111.8242
40.5279 -111.8265
40.5248 -111.8291
40.5225 -111.8316
40.5207 -111.8337
40.5184 -111.8355
40.5166 -111.8365
40.5143 -111.8378
40.5122 -111.8391
40.5094 -111.8388
40.5071 -111.8388
40.5047 -111.8381
40.5027 -111.8373
40.5011 -111.8363
40.5001 -111.8352
40.4985 -111.8336

Name: 2351f Wasatch Fault SLC Pechmann (dip 65)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.04800000
Deterministic Magnitude: 7.07

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	7.690e-004	6.630000	7.110000	0.000000	6.870000	0.120000	0.000000	0.000000
Normal	0.600000	Activity	7.690e-004	6.830000	7.310000	0.000000	7.070000	0.120000	0.000000	0.000000
Normal	0.200000	Activity	7.690e-004	7.030000	7.510000	0.000000	7.270000	0.120000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.8091	-111.9129
40.7927	-111.9003
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7796	-111.8906
40.7785	-111.8903
40.7777	-111.8902
40.7769	-111.8900
40.7761	-111.8898
40.7755	-111.8897
40.7748	-111.8897
40.7741	-111.8897
40.7734	-111.8898
40.7724	-111.8901
40.7716	-111.8903
40.7710	-111.8906
40.7704	-111.8908
40.7700	-111.8908
40.7689	-111.8913
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7706	-111.8476
40.7697	-111.8488
40.7691	-111.8498
40.7683	-111.8505
40.7677	-111.8515
40.7670	-111.8527
40.7660	-111.8546
40.7651	-111.8564
40.7642	-111.8577
40.7633	-111.8589
40.7627	-111.8596
40.7618	-111.8609
40.7608	-111.8619
40.7600	-111.8628
40.7588	-111.8634
40.7576	-111.8637
40.7566	-111.8636
40.7557	-111.8634
40.7547	-111.8629
40.7539	-111.8623
40.7530	-111.8618
40.7521	-111.8608
40.7514	-111.8601
40.7507	-111.8595
40.7501	-111.8590
40.7477	-111.8574
40.7456	-111.8569
40.7443	-111.8564
40.7430	-111.8559
40.7414	-111.8548
40.7396	-111.8546
40.7373	-111.8546
40.7354	-111.8556
40.7339	-111.8574
40.7326	-111.8587
40.7318	-111.8598

40.7302 -111.8603
40.7287 -111.8598
40.7268 -111.8598
40.7250 -111.8601
40.7232 -111.8601
40.7211 -111.8601
40.7189 -111.8602
40.7172 -111.8611
40.7156 -111.8619
40.7142 -111.8624
40.7129 -111.8624
40.7113 -111.8621
40.7103 -111.8614
40.7095 -111.8607
40.7082 -111.8595
40.7072 -111.8584
40.7060 -111.8574
40.7046 -111.8564
40.7035 -111.8555
40.7022 -111.8538
40.7007 -111.8522
40.6986 -111.8512
40.6966 -111.8509
40.6945 -111.8488
40.6927 -111.8475
40.6908 -111.8457
40.6890 -111.8452
40.6864 -111.8441
40.6864 -111.8431
40.6833 -111.8418
40.6814 -111.8407
40.6799 -111.8394
40.6788 -111.8381
40.6778 -111.8368
40.6770 -111.8360
40.6754 -111.8353
40.6739 -111.8342
40.6726 -111.8315
40.6718 -111.8291
40.6710 -111.8265
40.6705 -111.8241
40.6697 -111.8218
40.6692 -111.8200
40.6687 -111.8179
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40.6676 -111.8137
40.6671 -111.8119
40.6666 -111.8103
40.6661 -111.8093
40.6658 -111.8077
40.6658 -111.8072
40.6635 -111.8067
40.6619 -111.8064
40.6606 -111.8064
40.6588 -111.8067
40.6572 -111.8072
40.6554 -111.8075
40.6543 -111.8082
40.6538 -111.8085
40.6523 -111.8085
40.6504 -111.8085
40.6486 -111.8069
40.6478 -111.8059
40.6473 -111.8048
40.6455 -111.8035
40.6436 -111.8022
40.6413 -111.8007
40.6397 -111.7994
40.6387 -111.7986
40.6358 -111.7994
40.6340 -111.7996
40.6319 -111.7991
40.6298 -111.7978
40.6285 -111.7965
40.6267 -111.7954
40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7908
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
40.6100 -111.7905
40.6082 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931

40.6006	-111.7936
40.5990	-111.7936
40.5977	-111.7928
40.5951	-111.7921
40.5938	-111.7910
40.5928	-111.7900
40.5912	-111.7892
40.5894	-111.7889
40.5873	-111.7902
40.5857	-111.7918
40.5834	-111.7934
40.5821	-111.7949
40.5791	-111.7953
40.5766	-111.7953
40.5750	-111.7956
40.5730	-111.7956
40.5712	-111.7959
40.5696	-111.7959
40.5681	-111.7951
40.5660	-111.7943
40.5642	-111.7943
40.5624	-111.7948
40.5609	-111.7977
40.5593	-111.7982
40.5578	-111.7982
40.5562	-111.7994
40.5544	-111.7994
40.5526	-111.7997
40.5511	-111.8007
40.5482	-111.8020
40.5467	-111.8038
40.5446	-111.8061
40.5433	-111.8077
40.5423	-111.8092
40.5413	-111.8108
40.5390	-111.8123
40.5372	-111.8136
40.5354	-111.8149
40.5328	-111.8190
40.5310	-111.8211
40.5300	-111.8242
40.5279	-111.8265
40.5248	-111.8291
40.5225	-111.8316
40.5207	-111.8337
40.5184	-111.8355
40.5166	-111.8365
40.5143	-111.8378
40.5122	-111.8391
40.5094	-111.8388
40.5071	-111.8388
40.5047	-111.8381
40.5027	-111.8373
40.5011	-111.8363
40.5001	-111.8352
40.4985	-111.8336

Name: 2351f_alt3 Wasatch Fault SLC through Virginia St flt - Partial GR (dip 35)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.01598400
Deterministic Magnitude: 7.05

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Exponential	0.2	Activity	2.318e-003	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.600000	Activity	3.108e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.200000	Activity	3.653e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.8091	-111.9129
40.7927	-111.9003
40.7813	-111.8914

40.7807 -111.8911
40.7802 -111.8908
40.7750 -111.8413
40.7739 -111.8427
40.7727 -111.8442
40.7715 -111.8463
40.7706 -111.8476
40.7697 -111.8488
40.7691 -111.8498
40.7683 -111.8505
40.7677 -111.8515
40.7670 -111.8527
40.7660 -111.8546
40.7651 -111.8564
40.7642 -111.8577
40.7633 -111.8589
40.7627 -111.8596
40.7618 -111.8609
40.7608 -111.8619
40.7600 -111.8628
40.7588 -111.8634
40.7576 -111.8637
40.7566 -111.8636
40.7557 -111.8634
40.7547 -111.8629
40.7539 -111.8623
40.7530 -111.8618
40.7521 -111.8608
40.7514 -111.8601
40.7507 -111.8595
40.7501 -111.8590
40.7477 -111.8574
40.7456 -111.8569
40.7443 -111.8564
40.7430 -111.8559
40.7414 -111.8548
40.7396 -111.8546
40.7373 -111.8546
40.7354 -111.8556
40.7339 -111.8574
40.7326 -111.8587
40.7318 -111.8598
40.7302 -111.8603
40.7287 -111.8598
40.7268 -111.8598
40.7250 -111.8601
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40.7211 -111.8601
40.7189 -111.8602
40.7172 -111.8611
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40.7142 -111.8624
40.7129 -111.8624
40.7113 -111.8621
40.7103 -111.8614
40.7095 -111.8607
40.7082 -111.8595
40.7072 -111.8584
40.7060 -111.8574
40.7046 -111.8564
40.7035 -111.8555
40.7022 -111.8538
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40.6986 -111.8512
40.6966 -111.8509
40.6945 -111.8488
40.6927 -111.8475
40.6908 -111.8457
40.6890 -111.8452
40.6864 -111.8441
40.6864 -111.8431
40.6833 -111.8418
40.6814 -111.8407
40.6799 -111.8394
40.6788 -111.8381
40.6778 -111.8368
40.6770 -111.8360
40.6754 -111.8353
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40.6726 -111.8315
40.6718 -111.8291
40.6710 -111.8265
40.6705 -111.8241
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40.6692 -111.8200
40.6687 -111.8179
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40.6676 -111.8137
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40.6666 -111.8103

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40.6658 -111.8072
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40.6619 -111.8064
40.6606 -111.8064
40.6588 -111.8067
40.6572 -111.8072
40.6554 -111.8075
40.6543 -111.8082
40.6538 -111.8085
40.6523 -111.8085
40.6504 -111.8085
40.6486 -111.8069
40.6478 -111.8059
40.6473 -111.8048
40.6455 -111.8035
40.6436 -111.8022
40.6413 -111.8007
40.6397 -111.7994
40.6387 -111.7986
40.6358 -111.7994
40.6340 -111.7996
40.6319 -111.7991
40.6298 -111.7978
40.6285 -111.7965
40.6267 -111.7954
40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7908
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
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40.6082 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
40.5990 -111.7936
40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
40.5894 -111.7889
40.5873 -111.7902
40.5857 -111.7918
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40.5791 -111.7953
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40.5750 -111.7956
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40.5681 -111.7951
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40.5642 -111.7943
40.5624 -111.7948
40.5609 -111.7977
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40.5578 -111.7982
40.5562 -111.7994
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40.5482 -111.8020
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40.5423 -111.8092
40.5413 -111.8108
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40.5354 -111.8149
40.5328 -111.8190
40.5310 -111.8211
40.5300 -111.8242
40.5279 -111.8265
40.5248 -111.8291
40.5225 -111.8316
40.5207 -111.8337
40.5184 -111.8355
40.5166 -111.8365
40.5143 -111.8378

40.5122	-111.8391
40.5094	-111.8388
40.5071	-111.8388
40.5047	-111.8381
40.5027	-111.8373
40.5011	-111.8363
40.5001	-111.8352
40.4985	-111.8336

Name: 2351f_alt3 Wasatch Fault SLC through Virginia St flt - Partial GR (dip 50)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.04795200
Deterministic Magnitude: 7.05

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Exponential	0.2	Activity	2.318e-003	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.600000	Activity	3.108e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.200000	Activity	3.653e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.8091	-111.9129
40.7927	-111.9003
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7706	-111.8476
40.7697	-111.8488
40.7691	-111.8498
40.7683	-111.8505
40.7677	-111.8515
40.7670	-111.8527
40.7660	-111.8546
40.7651	-111.8564
40.7642	-111.8577
40.7633	-111.8589
40.7627	-111.8596
40.7618	-111.8609
40.7608	-111.8619
40.7600	-111.8628
40.7588	-111.8634
40.7576	-111.8637
40.7566	-111.8636
40.7557	-111.8634
40.7547	-111.8629
40.7539	-111.8623
40.7530	-111.8618
40.7521	-111.8608
40.7514	-111.8601
40.7507	-111.8595
40.7501	-111.8590
40.7477	-111.8574
40.7456	-111.8569
40.7443	-111.8564
40.7430	-111.8559
40.7414	-111.8548
40.7396	-111.8546
40.7373	-111.8546
40.7354	-111.8556
40.7339	-111.8574
40.7326	-111.8587
40.7318	-111.8598
40.7302	-111.8603
40.7287	-111.8598
40.7268	-111.8598
40.7250	-111.8601
40.7232	-111.8601
40.7211	-111.8601

40.7189 -111.8602
40.7172 -111.8611
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40.7129 -111.8624
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40.6726 -111.8315
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40.6455 -111.8035
40.6436 -111.8022
40.6413 -111.8007
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40.6358 -111.7994
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40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7908
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
40.6100 -111.7905
40.6082 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
40.5990 -111.7936
40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900

40.5912	-111.7892
40.5894	-111.7889
40.5873	-111.7902
40.5857	-111.7918
40.5834	-111.7934
40.5821	-111.7949
40.5791	-111.7953
40.5766	-111.7953
40.5750	-111.7956
40.5730	-111.7956
40.5712	-111.7959
40.5696	-111.7959
40.5681	-111.7951
40.5660	-111.7943
40.5642	-111.7943
40.5624	-111.7948
40.5609	-111.7977
40.5593	-111.7982
40.5578	-111.7982
40.5562	-111.7994
40.5544	-111.7994
40.5526	-111.7997
40.5511	-111.8007
40.5482	-111.8020
40.5467	-111.8038
40.5446	-111.8061
40.5433	-111.8077
40.5423	-111.8092
40.5413	-111.8108
40.5390	-111.8123
40.5372	-111.8136
40.5354	-111.8149
40.5328	-111.8190
40.5310	-111.8211
40.5300	-111.8242
40.5279	-111.8265
40.5248	-111.8291
40.5225	-111.8316
40.5207	-111.8337
40.5184	-111.8355
40.5166	-111.8365
40.5143	-111.8378
40.5122	-111.8391
40.5094	-111.8388
40.5071	-111.8388
40.5047	-111.8381
40.5027	-111.8373
40.5011	-111.8363
40.5001	-111.8352
40.4985	-111.8336

Name: 2351f_alt3 Wasatch Fault SLC through Virginia St flt - Partial GR (dip 65)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.01598400
Deterministic Magnitude: 7.05

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Exponential	0.2	Activity	2.318e-003	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.600000	Activity	3.108e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.200000	Activity	3.653e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.8091	-111.9129
40.7927	-111.9003
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463

40.7706 -111.8476
40.7697 -111.8488
40.7691 -111.8498
40.7683 -111.8505
40.7677 -111.8515
40.7670 -111.8527
40.7660 -111.8546
40.7651 -111.8564
40.7642 -111.8577
40.7633 -111.8589
40.7627 -111.8596
40.7618 -111.8609
40.7608 -111.8619
40.7600 -111.8628
40.7588 -111.8634
40.7576 -111.8637
40.7566 -111.8636
40.7557 -111.8634
40.7547 -111.8629
40.7539 -111.8623
40.7530 -111.8618
40.7521 -111.8608
40.7514 -111.8601
40.7507 -111.8595
40.7501 -111.8590
40.7477 -111.8574
40.7456 -111.8569
40.7443 -111.8564
40.7430 -111.8559
40.7414 -111.8548
40.7396 -111.8546
40.7373 -111.8546
40.7354 -111.8556
40.7339 -111.8574
40.7326 -111.8587
40.7318 -111.8598
40.7302 -111.8603
40.7287 -111.8598
40.7268 -111.8598
40.7250 -111.8601
40.7232 -111.8601
40.7211 -111.8601
40.7189 -111.8602
40.7172 -111.8611
40.7156 -111.8619
40.7142 -111.8624
40.7129 -111.8624
40.7113 -111.8621
40.7103 -111.8614
40.7095 -111.8607
40.7082 -111.8595
40.7072 -111.8584
40.7060 -111.8574
40.7046 -111.8564
40.7035 -111.8555
40.7022 -111.8538
40.7007 -111.8522
40.6986 -111.8512
40.6966 -111.8509
40.6945 -111.8488
40.6927 -111.8475
40.6908 -111.8457
40.6890 -111.8452
40.6864 -111.8441
40.6864 -111.8431
40.6833 -111.8418
40.6814 -111.8407
40.6799 -111.8394
40.6788 -111.8381
40.6778 -111.8368
40.6770 -111.8360
40.6754 -111.8353
40.6739 -111.8342
40.6726 -111.8315
40.6718 -111.8291
40.6710 -111.8265
40.6705 -111.8241
40.6697 -111.8218
40.6692 -111.8200
40.6687 -111.8179
40.6682 -111.8158
40.6676 -111.8137
40.6671 -111.8119
40.6666 -111.8103
40.6661 -111.8093
40.6658 -111.8077
40.6658 -111.8072
40.6635 -111.8067
40.6619 -111.8064
40.6606 -111.8064

40.6588 -111.8067
40.6572 -111.8072
40.6554 -111.8075
40.6543 -111.8082
40.6538 -111.8085
40.6523 -111.8085
40.6504 -111.8085
40.6486 -111.8069
40.6478 -111.8059
40.6473 -111.8048
40.6455 -111.8035
40.6436 -111.8022
40.6413 -111.8007
40.6397 -111.7994
40.6387 -111.7986
40.6358 -111.7994
40.6340 -111.7996
40.6319 -111.7991
40.6298 -111.7978
40.6285 -111.7965
40.6267 -111.7954
40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7908
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
40.6100 -111.7905
40.6082 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
40.5990 -111.7936
40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
40.5894 -111.7889
40.5873 -111.7902
40.5857 -111.7918
40.5834 -111.7934
40.5821 -111.7949
40.5791 -111.7953
40.5766 -111.7953
40.5750 -111.7956
40.5730 -111.7956
40.5712 -111.7959
40.5696 -111.7959
40.5681 -111.7951
40.5660 -111.7943
40.5642 -111.7943
40.5624 -111.7948
40.5609 -111.7977
40.5593 -111.7982
40.5578 -111.7982
40.5562 -111.7994
40.5544 -111.7994
40.5526 -111.7997
40.5511 -111.8007
40.5482 -111.8020
40.5467 -111.8038
40.5446 -111.8061
40.5433 -111.8077
40.5423 -111.8092
40.5413 -111.8108
40.5390 -111.8123
40.5372 -111.8136
40.5354 -111.8149
40.5328 -111.8190
40.5310 -111.8211
40.5300 -111.8242
40.5279 -111.8265
40.5248 -111.8291
40.5225 -111.8316
40.5207 -111.8337
40.5184 -111.8355
40.5166 -111.8365
40.5143 -111.8378
40.5122 -111.8391
40.5094 -111.8388
40.5071 -111.8388
40.5047 -111.8381
40.5027 -111.8373
40.5011 -111.8363

40.5001	-111.8352
40.4985	-111.8336

Name: SLC Cluster - Group1
Region: USGS 2014
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.24
Time Independent Cluster Rate (events/year): 0.000769
------ Start Nested Sources forSLC Cluster - Group1 -------
Name: g1 Wasatch fault, Salt Lake City Warm Springs-section.M from SRL (dip 50)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 6.231

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.2	Activity	7.690e-004	6.029000	6.031000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.600000	Activity	7.690e-004	6.229000	6.231000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.200000	Activity	7.690e-004	6.429000	6.431000	2.300000	0.000000	0.000000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8446	-111.8955
40.8420	-111.8977
40.8405	-111.8999
40.8393	-111.9018
40.8384	-111.9035
40.8362	-111.9059
40.8355	-111.9059
40.8343	-111.9081
40.8330	-111.9100
40.8318	-111.9122
40.8297	-111.9129
40.8280	-111.9134
40.8258	-111.9141
40.8239	-111.9141
40.8222	-111.9144
40.8202	-111.9149
40.8185	-111.9156
40.8171	-111.9161
40.8159	-111.9173
40.8140	-111.9163
40.8125	-111.9149
40.8108	-111.9136
40.8091	-111.9129
40.8074	-111.9120
40.8055	-111.9107
40.8038	-111.9093
40.8021	-111.9081
40.8004	-111.9066
40.7997	-111.9057
40.7990	-111.9045
40.7982	-111.9035
40.7973	-111.9025
40.7963	-111.9018
40.7949	-111.9016
40.7933	-111.9011
40.7927	-111.9003
40.7922	-111.8997
40.7917	-111.8992
40.7911	-111.8988
40.7905	-111.8983
40.7897	-111.8981
40.7891	-111.8980
40.7887	-111.8980
40.7881	-111.8978
40.7877	-111.8974
40.7874	-111.8970
40.7868	-111.8965
40.7862	-111.8961
40.7853	-111.8956
40.7847	-111.8950
40.7841	-111.8943
40.7836	-111.8937
40.7831	-111.8932
40.7828	-111.8926

40.7823	-111.8923
40.7819	-111.8918
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7796	-111.8906
40.7785	-111.8903
40.7777	-111.8902
40.7769	-111.8900
40.7761	-111.8898
40.7755	-111.8897
40.7748	-111.8897
40.7741	-111.8897
40.7734	-111.8898
40.7723	-111.8900
40.7716	-111.8903
40.7710	-111.8906
40.7704	-111.8908
40.7700	-111.8908
40.7689	-111.8913

Name: g1 Wasatch fault, Salt Lake City tear flt (dip 90)
Region: USGS 2014
Category:Fault
Fault Mechanism: Strike Slip
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 4.401

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	90	1	1.001	6

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.2	Activity	7.690e-004	4.199000	4.201000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.600000	Activity	7.690e-004	4.399000	4.401000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.200000	Activity	7.690e-004	4.599000	4.601000	2.300000	0.000000	0.000000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.7689	-111.8913
40.7691	-111.8890
40.7694	-111.8867
40.7697	-111.8847
40.7700	-111.8822
40.7703	-111.8797
40.7705	-111.8778
40.7708	-111.8758
40.7710	-111.8740
40.7713	-111.8713
40.7716	-111.8692
40.7718	-111.8670
40.7722	-111.8643
40.7725	-111.8618
40.7729	-111.8586
40.7732	-111.8559
40.7735	-111.8533
40.7739	-111.8504
40.7741	-111.8482
40.7744	-111.8454
40.7746	-111.8443
40.7747	-111.8430
40.7750	-111.8413

Name: g1 Wasatch fault, Salt Lake City East Bench&Cottonwood sections (dip 50)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 6.901

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.2	Activity	7.690e-004	6.699000	6.701000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.600000	Activity	7.690e-004	6.899000	6.901000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.200000	Activity	7.690e-004	7.099000	7.101000	2.300000	0.000000	0.000000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7705	-111.8476
40.7697	-111.8488
40.7690	-111.8498
40.7683	-111.8505
40.7677	-111.8515
40.7670	-111.8527
40.7660	-111.8546
40.7651	-111.8564
40.7642	-111.8577
40.7633	-111.8589
40.7627	-111.8596
40.7618	-111.8609
40.7608	-111.8619
40.7600	-111.8627
40.7588	-111.8634
40.7576	-111.8637
40.7566	-111.8636
40.7557	-111.8634
40.7547	-111.8629
40.7539	-111.8622
40.7530	-111.8617
40.7521	-111.8607
40.7514	-111.8601
40.7507	-111.8595
40.7501	-111.8590
40.7477	-111.8574
40.7456	-111.8569
40.7443	-111.8564
40.7430	-111.8559
40.7414	-111.8548
40.7396	-111.8546
40.7373	-111.8546
40.7354	-111.8556
40.7339	-111.8574
40.7326	-111.8587
40.7318	-111.8598
40.7302	-111.8603
40.7287	-111.8598
40.7268	-111.8598
40.7250	-111.8600
40.7232	-111.8600
40.7211	-111.8600
40.7189	-111.8602
40.7172	-111.8611
40.7156	-111.8619
40.7142	-111.8624
40.7129	-111.8624
40.7113	-111.8621
40.7103	-111.8614
40.7095	-111.8607
40.7082	-111.8595
40.7072	-111.8584
40.7060	-111.8574
40.7046	-111.8564
40.7035	-111.8555
40.7022	-111.8538
40.7007	-111.8522
40.6986	-111.8512
40.6966	-111.8509
40.6945	-111.8488
40.6926	-111.8475
40.6908	-111.8457
40.6890	-111.8452
40.6864	-111.8441
40.6864	-111.8431
40.6833	-111.8418
40.6814	-111.8407
40.6799	-111.8394
40.6788	-111.8381
40.6778	-111.8368
40.6770	-111.8360
40.6754	-111.8353
40.6739	-111.8342
40.6726	-111.8315
40.6718	-111.8291
40.6710	-111.8265
40.6705	-111.8241
40.6697	-111.8218
40.6692	-111.8200

40.6687 -111.8179
40.6682 -111.8158
40.6676 -111.8137
40.6671 -111.8119
40.6666 -111.8103
40.6661 -111.8093
40.6658 -111.8077
40.6658 -111.8072
40.6635 -111.8067
40.6619 -111.8064
40.6606 -111.8064
40.6588 -111.8067
40.6572 -111.8072
40.6554 -111.8074
40.6543 -111.8082
40.6538 -111.8085
40.6522 -111.8085
40.6504 -111.8085
40.6486 -111.8069
40.6478 -111.8059
40.6473 -111.8048
40.6455 -111.8035
40.6436 -111.8022
40.6413 -111.8007
40.6397 -111.7994
40.6387 -111.7986
40.6358 -111.7994
40.6340 -111.7996
40.6319 -111.7991
40.6298 -111.7978
40.6285 -111.7965
40.6267 -111.7954
40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7907
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
40.6100 -111.7905
40.6081 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
40.5990 -111.7936
40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
40.5894 -111.7889
40.5873 -111.7902
40.5857 -111.7918
40.5834 -111.7934
40.5821 -111.7949
40.5791 -111.7953
40.5766 -111.7953
40.5750 -111.7956
40.5730 -111.7956
40.5712 -111.7959
40.5696 -111.7959
40.5681 -111.7951
40.5660 -111.7943
40.5642 -111.7943
40.5624 -111.7948
40.5609 -111.7977
40.5593 -111.7982
40.5578 -111.7982
40.5562 -111.7995
40.5544 -111.7995
40.5526 -111.7997
40.5511 -111.8007
40.5482 -111.8020
40.5467 -111.8038
40.5446 -111.8061
40.5433 -111.8077
40.5423 -111.8092
40.5413 -111.8108
40.5390 -111.8123
40.5372 -111.8136
40.5354 -111.8149
40.5328 -111.8190
40.5310 -111.8211
40.5300 -111.8242
40.5279 -111.8265
40.5248 -111.8291

40.5225	-111.8316
40.5207	-111.8337
40.5184	-111.8355
40.5166	-111.8365
40.5143	-111.8378
40.5122	-111.8391
40.5094	-111.8388
40.5071	-111.8388
40.5047	-111.8381
40.5027	-111.8373
40.5011	-111.8363
40.5001	-111.8352
40.4985	-111.8336

------ End Nested Sources for SLC Cluster - Group1 -------

Name: SLC Cluster - Group2
Region: USGS 2014
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.24
Time Independent Cluster Rate (events/year): 0.000769
------ Start Nested Sources forSLC Cluster - Group2 -------
Name: g2 Wasatch fault, Salt Lake City Warm Springs-section.M from SRL (dip 35)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 6.231

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.2	Activity	7.690e-004	6.029000	6.031000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.600000	Activity	7.690e-004	6.229000	6.231000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.200000	Activity	7.690e-004	6.429000	6.431000	2.300000	0.000000	0.000000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8446	-111.8955
40.8420	-111.8977
40.8405	-111.8999
40.8393	-111.9018
40.8384	-111.9035
40.8362	-111.9059
40.8355	-111.9059
40.8343	-111.9081
40.8330	-111.9100
40.8318	-111.9122
40.8297	-111.9129
40.8280	-111.9134
40.8258	-111.9141
40.8239	-111.9141
40.8222	-111.9144
40.8202	-111.9149
40.8185	-111.9156
40.8171	-111.9161
40.8159	-111.9173
40.8140	-111.9163
40.8125	-111.9149
40.8108	-111.9136
40.8091	-111.9129
40.8074	-111.9120
40.8055	-111.9107
40.8038	-111.9093
40.8021	-111.9081
40.8004	-111.9066
40.7997	-111.9057
40.7990	-111.9045
40.7982	-111.9035
40.7973	-111.9025
40.7963	-111.9018
40.7949	-111.9016
40.7933	-111.9011
40.7927	-111.9003
40.7922	-111.8997
40.7917	-111.8992
40.7911	-111.8988
40.7905	-111.8983
40.7897	-111.8981

40.7891	-111.8980
40.7887	-111.8980
40.7881	-111.8978
40.7877	-111.8974
40.7874	-111.8970
40.7868	-111.8965
40.7862	-111.8961
40.7853	-111.8956
40.7847	-111.8950
40.7841	-111.8943
40.7836	-111.8937
40.7831	-111.8932
40.7828	-111.8926
40.7823	-111.8923
40.7819	-111.8918
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7796	-111.8906
40.7785	-111.8903
40.7777	-111.8902
40.7769	-111.8900
40.7761	-111.8898
40.7755	-111.8897
40.7748	-111.8897
40.7741	-111.8897
40.7734	-111.8898
40.7723	-111.8900
40.7716	-111.8903
40.7710	-111.8906
40.7704	-111.8908
40.7700	-111.8908
40.7689	-111.8913

Name: g2 Wasatch fault, Salt Lake City tear flt (dip 90)
Region: USGS 2014
Category:Fault
Fault Mechanism: Strike Slip
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 4.401

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	90	1	1.001	6

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.2	Activity	7.690e-004	4.199000	4.201000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.600000	Activity	7.690e-004	4.399000	4.401000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.200000	Activity	7.690e-004	4.599000	4.601000	2.300000	0.000000	0.000000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.7689	-111.8913
40.7691	-111.8890
40.7694	-111.8867
40.7697	-111.8847
40.7700	-111.8822
40.7703	-111.8797
40.7705	-111.8778
40.7708	-111.8758
40.7710	-111.8740
40.7713	-111.8713
40.7716	-111.8692
40.7718	-111.8670
40.7722	-111.8643
40.7725	-111.8618
40.7729	-111.8586
40.7732	-111.8559
40.7735	-111.8533
40.7739	-111.8504
40.7741	-111.8482
40.7744	-111.8454
40.7746	-111.8443
40.7747	-111.8430
40.7750	-111.8413

Name: g2 Wasatch fault, Salt Lake City East Bench&Cottonwood sections (dip 35)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000

Deterministic Magnitude: 6.901

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.2	Activity	7.690e-004	6.699000	6.701000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.600000	Activity	7.690e-004	6.899000	6.901000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.200000	Activity	7.690e-004	7.099000	7.101000	2.300000	0.000000	0.000000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7705	-111.8476
40.7697	-111.8488
40.7690	-111.8498
40.7683	-111.8505
40.7677	-111.8515
40.7670	-111.8527
40.7660	-111.8546
40.7651	-111.8564
40.7642	-111.8577
40.7633	-111.8589
40.7627	-111.8596
40.7618	-111.8609
40.7608	-111.8619
40.7600	-111.8627
40.7588	-111.8634
40.7576	-111.8637
40.7566	-111.8636
40.7557	-111.8634
40.7547	-111.8629
40.7539	-111.8622
40.7530	-111.8617
40.7521	-111.8607
40.7514	-111.8601
40.7507	-111.8595
40.7501	-111.8590
40.7477	-111.8574
40.7456	-111.8569
40.7443	-111.8564
40.7430	-111.8559
40.7414	-111.8548
40.7396	-111.8546
40.7373	-111.8546
40.7354	-111.8556
40.7339	-111.8574
40.7326	-111.8587
40.7318	-111.8598
40.7302	-111.8603
40.7287	-111.8598
40.7268	-111.8598
40.7250	-111.8600
40.7232	-111.8600
40.7211	-111.8600
40.7189	-111.8602
40.7172	-111.8611
40.7156	-111.8619
40.7142	-111.8624
40.7129	-111.8624
40.7113	-111.8621
40.7103	-111.8614
40.7095	-111.8607
40.7082	-111.8595
40.7072	-111.8584
40.7060	-111.8574
40.7046	-111.8564
40.7035	-111.8555
40.7022	-111.8538
40.7007	-111.8522
40.6986	-111.8512
40.6966	-111.8509
40.6945	-111.8488
40.6926	-111.8475
40.6908	-111.8457
40.6890	-111.8452
40.6864	-111.8441
40.6864	-111.8431
40.6833	-111.8418

40.6814 -111.8407
40.6799 -111.8394
40.6788 -111.8381
40.6778 -111.8368
40.6770 -111.8360
40.6754 -111.8353
40.6739 -111.8342
40.6726 -111.8315
40.6718 -111.8291
40.6710 -111.8265
40.6705 -111.8241
40.6697 -111.8218
40.6692 -111.8200
40.6687 -111.8179
40.6682 -111.8158
40.6676 -111.8137
40.6671 -111.8119
40.6666 -111.8103
40.6661 -111.8093
40.6658 -111.8077
40.6658 -111.8072
40.6635 -111.8067
40.6619 -111.8064
40.6606 -111.8064
40.6588 -111.8067
40.6572 -111.8072
40.6554 -111.8074
40.6543 -111.8082
40.6538 -111.8085
40.6522 -111.8085
40.6504 -111.8085
40.6486 -111.8069
40.6478 -111.8059
40.6473 -111.8048
40.6455 -111.8035
40.6436 -111.8022
40.6413 -111.8007
40.6397 -111.7994
40.6387 -111.7986
40.6358 -111.7994
40.6340 -111.7996
40.6319 -111.7991
40.6298 -111.7978
40.6285 -111.7965
40.6267 -111.7954
40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7907
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
40.6100 -111.7905
40.6081 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
40.5990 -111.7936
40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
40.5894 -111.7889
40.5873 -111.7902
40.5857 -111.7918
40.5834 -111.7934
40.5821 -111.7949
40.5791 -111.7953
40.5766 -111.7953
40.5750 -111.7956
40.5730 -111.7956
40.5712 -111.7958
40.5696 -111.7958
40.5681 -111.7951
40.5660 -111.7943
40.5642 -111.7943
40.5624 -111.7948
40.5609 -111.7977
40.5593 -111.7982
40.5578 -111.7982
40.5562 -111.7995
40.5544 -111.7995
40.5526 -111.7997
40.5511 -111.8007
40.5482 -111.8020

40.5467	-111.8038
40.5446	-111.8061
40.5433	-111.8077
40.5423	-111.8092
40.5413	-111.8108
40.5390	-111.8123
40.5372	-111.8136
40.5354	-111.8149
40.5328	-111.8190
40.5310	-111.8211
40.5300	-111.8242
40.5279	-111.8265
40.5248	-111.8291
40.5225	-111.8316
40.5207	-111.8337
40.5184	-111.8355
40.5166	-111.8365
40.5143	-111.8378
40.5122	-111.8391
40.5094	-111.8388
40.5071	-111.8388
40.5047	-111.8381
40.5027	-111.8373
40.5011	-111.8363
40.5001	-111.8352
40.4985	-111.8336

------ End Nested Sources for SLC Cluster - Group2 -------

Name: SLC Cluster - Group3
Region: USGS 2014
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.24
Time Independent Cluster Rate (events/year): 0.000769
------ Start Nested Sources forSLC Cluster - Group3 -------
Name: g3 Wasatch fault, Salt Lake City Warm Springs-section.M from SRL (dip 65)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 6.231

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.2	Activity	7.690e-004	6.029000	6.031000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.600000	Activity	7.690e-004	6.229000	6.231000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.200000	Activity	7.690e-004	6.429000	6.431000	2.300000	0.000000	0.000000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8446	-111.8955
40.8420	-111.8977
40.8405	-111.8999
40.8393	-111.9018
40.8384	-111.9035
40.8362	-111.9059
40.8355	-111.9059
40.8343	-111.9081
40.8330	-111.9100
40.8318	-111.9122
40.8297	-111.9129
40.8280	-111.9134
40.8258	-111.9141
40.8239	-111.9141
40.8222	-111.9144
40.8202	-111.9149
40.8185	-111.9156
40.8171	-111.9161
40.8159	-111.9173
40.8140	-111.9163
40.8125	-111.9149
40.8108	-111.9136
40.8091	-111.9129
40.8074	-111.9120
40.8055	-111.9107
40.8038	-111.9093
40.8021	-111.9081
40.8004	-111.9066

40.7997	-111.9057
40.7990	-111.9045
40.7982	-111.9035
40.7973	-111.9025
40.7963	-111.9018
40.7949	-111.9016
40.7933	-111.9011
40.7927	-111.9003
40.7922	-111.8997
40.7917	-111.8992
40.7911	-111.8988
40.7905	-111.8983
40.7897	-111.8981
40.7891	-111.8980
40.7887	-111.8980
40.7881	-111.8978
40.7877	-111.8974
40.7874	-111.8970
40.7868	-111.8965
40.7862	-111.8961
40.7853	-111.8956
40.7847	-111.8950
40.7841	-111.8943
40.7836	-111.8937
40.7831	-111.8932
40.7828	-111.8926
40.7823	-111.8923
40.7819	-111.8918
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7796	-111.8906
40.7785	-111.8903
40.7777	-111.8902
40.7769	-111.8900
40.7761	-111.8898
40.7755	-111.8897
40.7748	-111.8897
40.7741	-111.8897
40.7734	-111.8898
40.7723	-111.8900
40.7716	-111.8903
40.7710	-111.8906
40.7704	-111.8908
40.7700	-111.8908
40.7689	-111.8913

Name: g3 Wasatch fault, Salt Lake City tear flt (dip 90)
Region: USGS 2014
Category:Fault
Fault Mechanism: Strike Slip
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 4.401

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	90	1	1.001	6

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.2	Activity	7.690e-004	4.199000	4.201000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.600000	Activity	7.690e-004	4.399000	4.401000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.200000	Activity	7.690e-004	4.599000	4.601000	2.300000	0.000000	0.000000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.7689	-111.8913
40.7691	-111.8890
40.7694	-111.8867
40.7697	-111.8847
40.7700	-111.8822
40.7703	-111.8797
40.7705	-111.8778
40.7708	-111.8758
40.7710	-111.8740
40.7713	-111.8713
40.7716	-111.8692
40.7718	-111.8670
40.7722	-111.8643
40.7725	-111.8618
40.7729	-111.8586
40.7732	-111.8559
40.7735	-111.8533

40.7739	-111.8504
40.7741	-111.8482
40.7744	-111.8454
40.7746	-111.8443
40.7747	-111.8430
40.7750	-111.8413

Name: g3 Wasatch fault, Salt Lake City East Bench&Cottonwood sections (dip 65)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 6.901

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.2	Activity	7.690e-004	6.699000	6.701000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.600000	Activity	7.690e-004	6.899000	6.901000	2.300000	0.000000	0.000000	0.010000	10.000000
Characteristic	0.200000	Activity	7.690e-004	7.099000	7.101000	2.300000	0.000000	0.000000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7705	-111.8476
40.7697	-111.8488
40.7690	-111.8498
40.7683	-111.8505
40.7677	-111.8515
40.7670	-111.8527
40.7660	-111.8546
40.7651	-111.8564
40.7642	-111.8577
40.7633	-111.8589
40.7627	-111.8596
40.7618	-111.8609
40.7608	-111.8619
40.7600	-111.8627
40.7588	-111.8634
40.7576	-111.8637
40.7566	-111.8636
40.7557	-111.8634
40.7547	-111.8629
40.7539	-111.8622
40.7530	-111.8617
40.7521	-111.8607
40.7514	-111.8601
40.7507	-111.8595
40.7501	-111.8590
40.7477	-111.8574
40.7456	-111.8569
40.7443	-111.8564
40.7430	-111.8559
40.7414	-111.8548
40.7396	-111.8546
40.7373	-111.8546
40.7354	-111.8556
40.7339	-111.8574
40.7326	-111.8587
40.7318	-111.8598
40.7302	-111.8603
40.7287	-111.8598
40.7268	-111.8598
40.7250	-111.8600
40.7232	-111.8600
40.7211	-111.8600
40.7189	-111.8602
40.7172	-111.8611
40.7156	-111.8619
40.7142	-111.8624
40.7129	-111.8624
40.7113	-111.8621
40.7103	-111.8614
40.7095	-111.8607
40.7082	-111.8595
40.7072	-111.8584
40.7060	-111.8574

40.7046 -111.8564
40.7035 -111.8555
40.7022 -111.8538
40.7007 -111.8522
40.6986 -111.8512
40.6966 -111.8509
40.6945 -111.8488
40.6926 -111.8475
40.6908 -111.8457
40.6890 -111.8452
40.6864 -111.8441
40.6864 -111.8431
40.6833 -111.8418
40.6814 -111.8407
40.6799 -111.8394
40.6788 -111.8381
40.6778 -111.8368
40.6770 -111.8360
40.6754 -111.8353
40.6739 -111.8342
40.6726 -111.8315
40.6718 -111.8291
40.6710 -111.8265
40.6705 -111.8241
40.6697 -111.8218
40.6692 -111.8200
40.6687 -111.8179
40.6682 -111.8158
40.6676 -111.8137
40.6671 -111.8119
40.6666 -111.8103
40.6661 -111.8093
40.6658 -111.8077
40.6658 -111.8072
40.6635 -111.8067
40.6619 -111.8064
40.6606 -111.8064
40.6588 -111.8067
40.6572 -111.8072
40.6554 -111.8074
40.6543 -111.8082
40.6538 -111.8085
40.6522 -111.8085
40.6504 -111.8085
40.6486 -111.8069
40.6478 -111.8059
40.6473 -111.8048
40.6455 -111.8035
40.6436 -111.8022
40.6413 -111.8007
40.6397 -111.7994
40.6387 -111.7986
40.6358 -111.7994
40.6340 -111.7996
40.6319 -111.7991
40.6298 -111.7978
40.6285 -111.7965
40.6267 -111.7954
40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7907
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
40.6100 -111.7905
40.6081 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
40.5990 -111.7936
40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
40.5894 -111.7889
40.5873 -111.7902
40.5857 -111.7918
40.5834 -111.7934
40.5821 -111.7949
40.5791 -111.7953
40.5766 -111.7953
40.5750 -111.7956
40.5730 -111.7956
40.5712 -111.7958

40.5696	-111.7958
40.5681	-111.7951
40.5660	-111.7943
40.5642	-111.7943
40.5624	-111.7948
40.5609	-111.7977
40.5593	-111.7982
40.5578	-111.7982
40.5562	-111.7995
40.5544	-111.7995
40.5526	-111.7997
40.5511	-111.8007
40.5482	-111.8020
40.5467	-111.8038
40.5446	-111.8061
40.5433	-111.8077
40.5423	-111.8092
40.5413	-111.8108
40.5390	-111.8123
40.5372	-111.8136
40.5354	-111.8149
40.5328	-111.8190
40.5310	-111.8211
40.5300	-111.8242
40.5279	-111.8265
40.5248	-111.8291
40.5225	-111.8316
40.5207	-111.8337
40.5184	-111.8355
40.5166	-111.8365
40.5143	-111.8378
40.5122	-111.8391
40.5094	-111.8388
40.5071	-111.8388
40.5047	-111.8381
40.5027	-111.8373
40.5011	-111.8363
40.5001	-111.8352
40.4985	-111.8336

------ End Nested Sources for SLC Cluster - Group3 -------

Name: 2351f_alt3 Wasatch Fault SLC through Virginia St flt - Full Char (dip 35)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.03201600
Deterministic Magnitude: 7.05

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	7.690e-004	6.610000	7.090000	0.000000	6.850000	0.120000	0.000000	0.000000
Normal	0.600000	Activity	7.690e-004	6.810000	7.290000	0.000000	7.050000	0.120000	0.000000	0.000000
Normal	0.200000	Activity	7.690e-004	7.010000	7.490000	0.000000	7.250000	0.120000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.8091	-111.9129
40.7927	-111.9003
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7706	-111.8476
40.7697	-111.8488
40.7691	-111.8498
40.7683	-111.8505
40.7677	-111.8515
40.7670	-111.8527
40.7660	-111.8546
40.7651	-111.8564
40.7642	-111.8577

40.7633 -111.8589
40.7627 -111.8596
40.7618 -111.8609
40.7608 -111.8619
40.7600 -111.8628
40.7588 -111.8634
40.7576 -111.8637
40.7566 -111.8636
40.7557 -111.8634
40.7547 -111.8629
40.7539 -111.8623
40.7530 -111.8618
40.7521 -111.8608
40.7514 -111.8601
40.7507 -111.8595
40.7501 -111.8590
40.7477 -111.8574
40.7456 -111.8569
40.7443 -111.8564
40.7430 -111.8559
40.7414 -111.8548
40.7396 -111.8546
40.7373 -111.8546
40.7354 -111.8556
40.7339 -111.8574
40.7326 -111.8587
40.7318 -111.8598
40.7302 -111.8603
40.7287 -111.8598
40.7268 -111.8598
40.7250 -111.8601
40.7232 -111.8601
40.7211 -111.8601
40.7189 -111.8602
40.7172 -111.8611
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40.7113 -111.8621
40.7103 -111.8614
40.7095 -111.8607
40.7082 -111.8595
40.7072 -111.8584
40.7060 -111.8574
40.7046 -111.8564
40.7035 -111.8555
40.7022 -111.8538
40.7007 -111.8522
40.6986 -111.8512
40.6966 -111.8509
40.6945 -111.8488
40.6927 -111.8475
40.6908 -111.8457
40.6890 -111.8452
40.6864 -111.8441
40.6864 -111.8431
40.6833 -111.8418
40.6814 -111.8407
40.6799 -111.8394
40.6788 -111.8381
40.6778 -111.8368
40.6770 -111.8360
40.6754 -111.8353
40.6739 -111.8342
40.6726 -111.8315
40.6718 -111.8291
40.6710 -111.8265
40.6705 -111.8241
40.6697 -111.8218
40.6692 -111.8200
40.6687 -111.8179
40.6682 -111.8158
40.6676 -111.8137
40.6671 -111.8119
40.6666 -111.8103
40.6661 -111.8093
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40.6658 -111.8072
40.6635 -111.8067
40.6619 -111.8064
40.6606 -111.8064
40.6588 -111.8067
40.6572 -111.8072
40.6554 -111.8075
40.6543 -111.8082
40.6538 -111.8085
40.6523 -111.8085
40.6504 -111.8085
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40.6478 -111.8059

40.6473 -111.8048
40.6455 -111.8035
40.6436 -111.8022
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40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
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40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
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40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
40.5894 -111.7889
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40.5791 -111.7953
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40.5750 -111.7956
40.5730 -111.7956
40.5712 -111.7959
40.5696 -111.7959
40.5681 -111.7951
40.5660 -111.7943
40.5642 -111.7943
40.5624 -111.7948
40.5609 -111.7977
40.5593 -111.7982
40.5578 -111.7982
40.5562 -111.7994
40.5544 -111.7994
40.5526 -111.7997
40.5511 -111.8007
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40.5467 -111.8038
40.5446 -111.8061
40.5433 -111.8077
40.5423 -111.8092
40.5413 -111.8108
40.5390 -111.8123
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40.5354 -111.8149
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40.5310 -111.8211
40.5300 -111.8242
40.5279 -111.8265
40.5248 -111.8291
40.5225 -111.8316
40.5207 -111.8337
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40.5122 -111.8391
40.5094 -111.8388
40.5071 -111.8388
40.5047 -111.8381
40.5027 -111.8373
40.5011 -111.8363
40.5001 -111.8352
40.4985 -111.8336

Name: 2351f_alt3 Wasatch Fault SLC through Virginia St flt - Full Char (dip 50)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.09604800

Deterministic Magnitude: 7.05

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	7.690e-004	6.610000	7.090000	0.000000	6.850000	0.120000	0.000000	0.000000
Normal	0.600000	Activity	7.690e-004	6.810000	7.290000	0.000000	7.050000	0.120000	0.000000	0.000000
Normal	0.200000	Activity	7.690e-004	7.010000	7.490000	0.000000	7.250000	0.120000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.8091	-111.9129
40.7927	-111.9003
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7706	-111.8476
40.7697	-111.8488
40.7691	-111.8498
40.7683	-111.8505
40.7677	-111.8515
40.7670	-111.8527
40.7660	-111.8546
40.7651	-111.8564
40.7642	-111.8577
40.7633	-111.8589
40.7627	-111.8596
40.7618	-111.8609
40.7608	-111.8619
40.7600	-111.8628
40.7588	-111.8634
40.7576	-111.8637
40.7566	-111.8636
40.7557	-111.8634
40.7547	-111.8629
40.7539	-111.8623
40.7530	-111.8618
40.7521	-111.8608
40.7514	-111.8601
40.7507	-111.8595
40.7501	-111.8590
40.7477	-111.8574
40.7456	-111.8569
40.7443	-111.8564
40.7430	-111.8559
40.7414	-111.8548
40.7396	-111.8546
40.7373	-111.8546
40.7354	-111.8556
40.7339	-111.8574
40.7326	-111.8587
40.7318	-111.8598
40.7302	-111.8603
40.7287	-111.8598
40.7268	-111.8598
40.7250	-111.8601
40.7232	-111.8601
40.7211	-111.8601
40.7189	-111.8602
40.7172	-111.8611
40.7156	-111.8619
40.7142	-111.8624
40.7129	-111.8624
40.7113	-111.8621
40.7103	-111.8614
40.7095	-111.8607
40.7082	-111.8595
40.7072	-111.8584
40.7060	-111.8574
40.7046	-111.8564
40.7035	-111.8555
40.7022	-111.8538
40.7007	-111.8522

40.6986 -111.8512
40.6966 -111.8509
40.6945 -111.8488
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40.6908 -111.8457
40.6890 -111.8452
40.6864 -111.8441
40.6864 -111.8431
40.6833 -111.8418
40.6814 -111.8407
40.6799 -111.8394
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40.6770 -111.8360
40.6754 -111.8353
40.6739 -111.8342
40.6726 -111.8315
40.6718 -111.8291
40.6710 -111.8265
40.6705 -111.8241
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40.6692 -111.8200
40.6687 -111.8179
40.6682 -111.8158
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40.6658 -111.8072
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40.6543 -111.8082
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40.6144 -111.7876
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40.6082 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
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40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
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40.5730 -111.7956
40.5712 -111.7959
40.5696 -111.7959
40.5681 -111.7951
40.5660 -111.7943
40.5642 -111.7943

40.5624	-111.7948
40.5609	-111.7977
40.5593	-111.7982
40.5578	-111.7982
40.5562	-111.7994
40.5544	-111.7994
40.5526	-111.7997
40.5511	-111.8007
40.5482	-111.8020
40.5467	-111.8038
40.5446	-111.8061
40.5433	-111.8077
40.5423	-111.8092
40.5413	-111.8108
40.5390	-111.8123
40.5372	-111.8136
40.5354	-111.8149
40.5328	-111.8190
40.5310	-111.8211
40.5300	-111.8242
40.5279	-111.8265
40.5248	-111.8291
40.5225	-111.8316
40.5207	-111.8337
40.5184	-111.8355
40.5166	-111.8365
40.5143	-111.8378
40.5122	-111.8391
40.5094	-111.8388
40.5071	-111.8388
40.5047	-111.8381
40.5027	-111.8373
40.5011	-111.8363
40.5001	-111.8352
40.4985	-111.8336

Name: 2351f_alt3 Wasatch Fault SLC through Virginia St flt - Full Char (dip 65)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.03201600
Deterministic Magnitude: 7.05

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	7.690e-004	6.610000	7.090000	0.000000	6.850000	0.120000	0.000000	0.000000
Normal	0.600000	Activity	7.690e-004	6.810000	7.290000	0.000000	7.050000	0.120000	0.000000	0.000000
Normal	0.200000	Activity	7.690e-004	7.010000	7.490000	0.000000	7.250000	0.120000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.8091	-111.9129
40.7927	-111.9003
40.7813	-111.8914
40.7807	-111.8911
40.7802	-111.8908
40.7750	-111.8413
40.7739	-111.8427
40.7727	-111.8442
40.7715	-111.8463
40.7706	-111.8476
40.7697	-111.8488
40.7691	-111.8498
40.7683	-111.8505
40.7677	-111.8515
40.7670	-111.8527
40.7660	-111.8546
40.7651	-111.8564
40.7642	-111.8577
40.7633	-111.8589
40.7627	-111.8596
40.7618	-111.8609
40.7608	-111.8619
40.7600	-111.8628
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40.6319 -111.7991
40.6298 -111.7978
40.6285 -111.7965
40.6267 -111.7954
40.6256 -111.7944
40.6243 -111.7939
40.6220 -111.7936
40.6207 -111.7921
40.6196 -111.7908
40.6191 -111.7894
40.6183 -111.7879
40.6162 -111.7871
40.6144 -111.7876
40.6121 -111.7889
40.6100 -111.7905
40.6082 -111.7913
40.6066 -111.7926
40.6050 -111.7931
40.6024 -111.7931
40.6006 -111.7936
40.5990 -111.7936
40.5977 -111.7928
40.5951 -111.7921
40.5938 -111.7910
40.5928 -111.7900
40.5912 -111.7892
40.5894 -111.7889
40.5873 -111.7902
40.5857 -111.7918
40.5834 -111.7934
40.5821 -111.7949
40.5791 -111.7953
40.5766 -111.7953
40.5750 -111.7956
40.5730 -111.7956
40.5712 -111.7959
40.5696 -111.7959
40.5681 -111.7951
40.5660 -111.7943
40.5642 -111.7943
40.5624 -111.7948
40.5609 -111.7977
40.5593 -111.7982
40.5578 -111.7982
40.5562 -111.7994
40.5544 -111.7994
40.5526 -111.7997
40.5511 -111.8007
40.5482 -111.8020
40.5467 -111.8038
40.5446 -111.8061
40.5433 -111.8077
40.5423 -111.8092
40.5413 -111.8108
40.5390 -111.8123
40.5372 -111.8136
40.5354 -111.8149
40.5328 -111.8190
40.5310 -111.8211
40.5300 -111.8242
40.5279 -111.8265
40.5248 -111.8291
40.5225 -111.8316
40.5207 -111.8337
40.5184 -111.8355
40.5166 -111.8365
40.5143 -111.8378
40.5122 -111.8391
40.5094 -111.8388
40.5071 -111.8388
40.5047 -111.8381
40.5027 -111.8373
40.5011 -111.8363
40.5001 -111.8352
40.4985 -111.8336

Name: 2351f Wasatch fault, Salt Lake City section - Full Char (dip 35)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.02401200
Deterministic Magnitude: 7.03

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	7.690e-004	6.590000	7.070000	0.000000	6.830000	0.120000	0.000000	0.000000
Normal	0.600000	Activity	7.690e-004	6.790000	7.270000	0.000000	7.030000	0.120000	0.000000	0.000000
Normal	0.200000	Activity	7.690e-004	6.990000	7.470000	0.000000	7.230000	0.120000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.7813	-111.8928
40.7687	-111.8922
40.7560	-111.8641
40.7473	-111.8579
40.7372	-111.8549
40.7307	-111.8606
40.7121	-111.8632
40.6816	-111.8417
40.6727	-111.8335
40.6737	-111.8082
40.6519	-111.8095
40.6308	-111.7997
40.6169	-111.7878
40.6047	-111.7942
40.5901	-111.7895
40.5811	-111.7961
40.5638	-111.7947
40.5490	-111.8014
40.5286	-111.8266
40.5130	-111.8391
40.5006	-111.8367
40.4950	-111.8217

Name: 2351f Wasatch fault, Salt Lake City section - Full Char (dip 50)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.07203600
Deterministic Magnitude: 7.03

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	7.690e-004	6.590000	7.070000	0.000000	6.830000	0.120000	0.000000	0.000000
Normal	0.600000	Activity	7.690e-004	6.790000	7.270000	0.000000	7.030000	0.120000	0.000000	0.000000
Normal	0.200000	Activity	7.690e-004	6.990000	7.470000	0.000000	7.230000	0.120000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.7813	-111.8928
40.7687	-111.8922
40.7560	-111.8641
40.7473	-111.8579
40.7372	-111.8549
40.7307	-111.8606
40.7121	-111.8632
40.6816	-111.8417
40.6727	-111.8335
40.6737	-111.8082
40.6519	-111.8095
40.6308	-111.7997
40.6169	-111.7878
40.6047	-111.7942
40.5901	-111.7895
40.5811	-111.7961
40.5638	-111.7947
40.5490	-111.8014
40.5286	-111.8266

40.5130	-111.8391
40.5006	-111.8367
40.4950	-111.8217

Name: 2351f Wasatch fault, Salt Lake City section - Full Char (dip 65)
Region: USGS 2014
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.02401200
Deterministic Magnitude: 7.03

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	7.690e-004	6.590000	7.070000	0.000000	6.830000	0.120000	0.000000	0.000000
Normal	0.600000	Activity	7.690e-004	6.790000	7.270000	0.000000	7.030000	0.120000	0.000000	0.000000
Normal	0.200000	Activity	7.690e-004	6.990000	7.470000	0.000000	7.230000	0.120000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.8494	-111.8870
40.8418	-111.8987
40.8303	-111.9135
40.8146	-111.9179
40.7813	-111.8928
40.7687	-111.8922
40.7560	-111.8641
40.7473	-111.8579
40.7372	-111.8549
40.7307	-111.8606
40.7121	-111.8632
40.6816	-111.8417
40.6727	-111.8335
40.6737	-111.8082
40.6519	-111.8095
40.6308	-111.7997
40.6169	-111.7878
40.6047	-111.7942
40.5901	-111.7895
40.5811	-111.7961
40.5638	-111.7947
40.5490	-111.8014
40.5286	-111.8266
40.5130	-111.8391
40.5006	-111.8367
40.4950	-111.8217

Name: Wasatch fault, all segs (dip 35)
Region: USGS 2008
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.02000000
Deterministic Magnitude: 7.401

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Exponential	0.2	Activity	5.910e-006	7.199000	7.201000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.600000	Activity	4.089e-006	7.399000	7.401000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.200000	Activity	2.829e-006	7.599000	7.601000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6521	-112.0475
41.6405	-112.0599
41.6307	-112.0545
41.6165	-112.0553
41.6106	-112.0412
41.5602	-112.0172
41.5542	-112.0191

41.5236 -111.9979
41.4992 -111.9879
41.4436 -112.0286
41.4277 -112.0282
41.4167 -112.0209
41.3807 -112.0246
41.3590 -111.9878
41.3334 -111.9607
41.3368 -111.9404
41.3069 -111.9299
41.2949 -111.9411
41.2772 -111.9483
41.2629 -111.9465
41.2598 -111.9390
41.2501 -111.9375
41.2407 -111.9270
41.2229 -111.9289
41.2149 -111.9235
41.2085 -111.9321
41.1869 -111.9388
41.1797 -111.9362
41.1768 -111.9282
41.1647 -111.9240
41.1509 -111.9061
41.1427 -111.9076
41.1314 -111.8975
41.1038 -111.9101
41.0853 -111.9036
41.0681 -111.9100
41.0557 -111.9032
41.0393 -111.9065
41.0292 -111.8989
41.0046 -111.8952
40.9993 -111.8844
40.9917 -111.8847
40.9771 -111.8739
40.9637 -111.8714
40.9608 -111.8787
40.9545 -111.8802
40.9460 -111.8735
40.9049 -111.8645
40.8906 -111.8519
40.8661 -111.8560
40.8494 -111.8863
40.8419 -111.8979
40.8304 -111.9128
40.8147 -111.9172
40.7813 -111.8920
40.7687 -111.8915
40.7561 -111.8634
40.7474 -111.8572
40.7372 -111.8541
40.7308 -111.8598
40.7122 -111.8625
40.6816 -111.8409
40.6727 -111.8327
40.6737 -111.8074
40.6520 -111.8087
40.6309 -111.7989
40.6169 -111.7870
40.6048 -111.7935
40.5902 -111.7887
40.5812 -111.7954
40.5638 -111.7939
40.5490 -111.8006
40.5287 -111.8258
40.5131 -111.8384
40.5007 -111.8360
40.4951 -111.8210
40.4858 -111.7530
40.4813 -111.7459
40.4761 -111.7438
40.4603 -111.7498
40.4554 -111.7455
40.4449 -111.7525
40.4344 -111.7523
40.4152 -111.7410
40.4110 -111.7428
40.3977 -111.7267
40.3846 -111.7199
40.3539 -111.6909
40.3418 -111.6753
40.3132 -111.6562
40.3119 -111.6377
40.2878 -111.6313
40.2781 -111.6345
40.2345 -111.6309
40.2122 -111.6232
40.2092 -111.6162
40.1947 -111.6085

40.1896	-111.5983
40.1727	-111.5964
40.1671	-111.5808
40.1489	-111.5550
40.1330	-111.5501
40.1273	-111.5575
40.1213	-111.5551
40.1005	-111.5709
40.0843	-111.5719
40.0836	-111.5959
40.0716	-111.6180
40.0486	-111.6345
40.0325	-111.6307
40.0063	-111.6429
40.0003	-111.7333
39.9923	-111.7511
39.9767	-111.7622
39.9444	-111.7571
39.9314	-111.7851
39.8824	-111.7910
39.8673	-111.8039
39.8286	-111.8064
39.8226	-111.8117
39.7507	-111.8278
39.7328	-111.8276
39.7067	-111.8157
39.7001	-111.8195
39.6434	-111.8268
39.6241	-111.8199
39.5741	-111.8209
39.5504	-111.8313
39.5272	-111.8613
39.5057	-111.8592
39.4888	-111.8709
39.4793	-111.8834
39.4572	-111.8844
39.4336	-111.9125
39.4212	-111.9140
39.4182	-111.9199
39.3864	-111.9184
39.3807	-111.9218

Name: Wasatch fault, all segs (dip 50)
Region: USGS 2008
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.06000000
Deterministic Magnitude: 7.401

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Exponential	0.2	Activity	5.595e-006	7.199000	7.201000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.600000	Activity	3.871e-006	7.399000	7.401000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.200000	Activity	2.678e-006	7.599000	7.601000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6521	-112.0475
41.6405	-112.0599
41.6307	-112.0545
41.6165	-112.0553
41.6106	-112.0412
41.5602	-112.0172
41.5542	-112.0191
41.5236	-111.9979
41.4992	-111.9879
41.4436	-112.0286
41.4277	-112.0282
41.4167	-112.0209
41.3807	-112.0246
41.3590	-111.9878
41.3334	-111.9607
41.3368	-111.9404
41.3069	-111.9299
41.2949	-111.9411
41.2772	-111.9483
41.2629	-111.9465
41.2598	-111.9390
41.2501	-111.9375

41.2407 -111.9270
41.2229 -111.9289
41.2149 -111.9235
41.2085 -111.9321
41.1869 -111.9388
41.1797 -111.9362
41.1768 -111.9282
41.1647 -111.9240
41.1509 -111.9061
41.1427 -111.9076
41.1314 -111.8975
41.1038 -111.9101
41.0853 -111.9036
41.0681 -111.9100
41.0557 -111.9032
41.0393 -111.9065
41.0292 -111.8989
41.0046 -111.8952
40.9993 -111.8844
40.9917 -111.8847
40.9771 -111.8739
40.9637 -111.8714
40.9608 -111.8787
40.9545 -111.8802
40.9460 -111.8735
40.9049 -111.8645
40.8906 -111.8519
40.8661 -111.8560
40.8494 -111.8863
40.8419 -111.8979
40.8304 -111.9128
40.8147 -111.9172
40.7813 -111.8920
40.7687 -111.8915
40.7561 -111.8634
40.7474 -111.8572
40.7372 -111.8541
40.7308 -111.8598
40.7122 -111.8625
40.6816 -111.8409
40.6727 -111.8327
40.6737 -111.8074
40.6520 -111.8087
40.6309 -111.7989
40.6169 -111.7870
40.6048 -111.7935
40.5902 -111.7887
40.5812 -111.7954
40.5638 -111.7939
40.5490 -111.8006
40.5287 -111.8258
40.5131 -111.8384
40.5007 -111.8360
40.4951 -111.8210
40.4858 -111.7530
40.4813 -111.7459
40.4761 -111.7438
40.4603 -111.7498
40.4554 -111.7455
40.4449 -111.7525
40.4344 -111.7523
40.4152 -111.7410
40.4110 -111.7428
40.3977 -111.7267
40.3846 -111.7199
40.3539 -111.6909
40.3418 -111.6753
40.3132 -111.6562
40.3119 -111.6377
40.2878 -111.6313
40.2781 -111.6345
40.2345 -111.6309
40.2122 -111.6232
40.2092 -111.6162
40.1947 -111.6085
40.1896 -111.5983
40.1727 -111.5964
40.1671 -111.5808
40.1489 -111.5550
40.1330 -111.5501
40.1273 -111.5575
40.1213 -111.5551
40.1005 -111.5709
40.0843 -111.5719
40.0836 -111.5959
40.0716 -111.6180
40.0486 -111.6345
40.0325 -111.6307
40.0063 -111.6429
40.0003 -111.7333

39.9923	-111.7511
39.9767	-111.7622
39.9444	-111.7571
39.9314	-111.7851
39.8824	-111.7910
39.8673	-111.8039
39.8286	-111.8064
39.8226	-111.8117
39.7507	-111.8278
39.7328	-111.8276
39.7067	-111.8157
39.7001	-111.8195
39.6434	-111.8268
39.6241	-111.8199
39.5741	-111.8209
39.5504	-111.8313
39.5272	-111.8613
39.5057	-111.8592
39.4888	-111.8709
39.4793	-111.8834
39.4572	-111.8844
39.4336	-111.9125
39.4212	-111.9140
39.4182	-111.9199
39.3864	-111.9184
39.3807	-111.9218

Name: Wasatch fault, all segs (dip 65)
Region: USGS 2008
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.02000000
Deterministic Magnitude: 7.401

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Exponential	0.2	Activity	5.144e-006	7.199000	7.201000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.600000	Activity	3.559e-006	7.399000	7.401000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.200000	Activity	2.462e-006	7.599000	7.601000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6521	-112.0475
41.6405	-112.0599
41.6307	-112.0545
41.6165	-112.0553
41.6106	-112.0412
41.5602	-112.0172
41.5542	-112.0191
41.5236	-111.9979
41.4992	-111.9879
41.4436	-112.0286
41.4277	-112.0282
41.4167	-112.0209
41.3807	-112.0246
41.3590	-111.9878
41.3334	-111.9607
41.3368	-111.9404
41.3069	-111.9299
41.2949	-111.9411
41.2772	-111.9483
41.2629	-111.9465
41.2598	-111.9390
41.2501	-111.9375
41.2407	-111.9270
41.2229	-111.9289
41.2149	-111.9235
41.2085	-111.9321
41.1869	-111.9388
41.1797	-111.9362
41.1768	-111.9282
41.1647	-111.9240
41.1509	-111.9061
41.1427	-111.9076
41.1314	-111.8975
41.1038	-111.9101
41.0853	-111.9036
41.0681	-111.9100
41.0557	-111.9032

41.0393 -111.9065
41.0292 -111.8989
41.0046 -111.8952
40.9993 -111.8844
40.9917 -111.8847
40.9771 -111.8739
40.9637 -111.8714
40.9608 -111.8787
40.9545 -111.8802
40.9460 -111.8735
40.9049 -111.8645
40.8906 -111.8519
40.8661 -111.8560
40.8494 -111.8863
40.8419 -111.8979
40.8304 -111.9128
40.8147 -111.9172
40.7813 -111.8920
40.7687 -111.8915
40.7561 -111.8634
40.7474 -111.8572
40.7372 -111.8541
40.7308 -111.8598
40.7122 -111.8625
40.6816 -111.8409
40.6727 -111.8327
40.6737 -111.8074
40.6520 -111.8087
40.6309 -111.7989
40.6169 -111.7870
40.6048 -111.7935
40.5902 -111.7887
40.5812 -111.7954
40.5638 -111.7939
40.5490 -111.8006
40.5287 -111.8258
40.5131 -111.8384
40.5007 -111.8360
40.4951 -111.8210
40.4858 -111.7530
40.4813 -111.7459
40.4761 -111.7438
40.4603 -111.7498
40.4554 -111.7455
40.4449 -111.7525
40.4344 -111.7523
40.4152 -111.7410
40.4110 -111.7428
40.3977 -111.7267
40.3846 -111.7199
40.3539 -111.6909
40.3418 -111.6753
40.3132 -111.6562
40.3119 -111.6377
40.2878 -111.6313
40.2781 -111.6345
40.2345 -111.6309
40.2122 -111.6232
40.2092 -111.6162
40.1947 -111.6085
40.1896 -111.5983
40.1727 -111.5964
40.1671 -111.5808
40.1489 -111.5550
40.1330 -111.5501
40.1273 -111.5575
40.1213 -111.5551
40.1005 -111.5709
40.0843 -111.5719
40.0836 -111.5959
40.0716 -111.6180
40.0486 -111.6345
40.0325 -111.6307
40.0063 -111.6429
40.0003 -111.7333
39.9923 -111.7511
39.9767 -111.7622
39.9444 -111.7571
39.9314 -111.7851
39.8824 -111.7910
39.8673 -111.8039
39.8286 -111.8064
39.8226 -111.8117
39.7507 -111.8278
39.7328 -111.8276
39.7067 -111.8157
39.7001 -111.8195
39.6434 -111.8268
39.6241 -111.8199
39.5741 -111.8209

39.5504	-111.8313
39.5272	-111.8613
39.5057	-111.8592
39.4888	-111.8709
39.4793	-111.8834
39.4572	-111.8844
39.4336	-111.9125
39.4212	-111.9140
39.4182	-111.9199
39.3864	-111.9184
39.3807	-111.9218

------ End Nested Sources for Salt Lake City - Wasatch Fault Source Model -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Morgan fault [2353abc]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forMorgan fault [2353abc] -------
Name: 2353abc Morgan fault (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.52

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	4.207e-005	6.080000	6.560000	2.300000	6.320000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.207e-005	6.280000	6.760000	2.300000	6.520000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.207e-005	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	4.678e-005	6.500000	6.520000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	3.658e-005	6.080000	6.560000	2.300000	6.320000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	3.658e-005	6.280000	6.760000	2.300000	6.520000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	3.658e-005	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	4.071e-005	6.500000	6.520000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	5.612e-005	6.080000	6.560000	2.300000	6.320000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.612e-005	6.280000	6.760000	2.300000	6.520000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.612e-005	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	6.238e-005	6.500000	6.520000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.1514	-111.7229
41.1067	-111.7067
41.0766	-111.6722
41.0273	-111.6687
41.0096	-111.6553

Name: 2353abc Morgan fault (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.52

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	4.207e-005	6.080000	6.560000	2.300000	6.320000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.207e-005	6.280000	6.760000	2.300000	6.520000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.207e-005	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	4.678e-005	6.500000	6.520000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	3.658e-005	6.080000	6.560000	2.300000	6.320000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	3.658e-005	6.280000	6.760000	2.300000	6.520000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	3.658e-005	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	4.071e-005	6.500000	6.520000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	5.612e-005	6.080000	6.560000	2.300000	6.320000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.612e-005	6.280000	6.760000	2.300000	6.520000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.612e-005	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	6.238e-005	6.500000	6.520000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.1514	-111.7229
41.1067	-111.7067
41.0766	-111.6722
41.0273	-111.6687
41.0096	-111.6553

Name: 2353abc Morgan fault (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.52

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	4.207e-005	6.080000	6.560000	2.300000	6.320000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.207e-005	6.280000	6.760000	2.300000	6.520000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.207e-005	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	4.678e-005	6.500000	6.520000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	3.658e-005	6.080000	6.560000	2.300000	6.320000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	3.658e-005	6.280000	6.760000	2.300000	6.520000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	3.658e-005	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	4.071e-005	6.500000	6.520000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	5.612e-005	6.080000	6.560000	2.300000	6.320000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.612e-005	6.280000	6.760000	2.300000	6.520000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.612e-005	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	6.238e-005	6.500000	6.520000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.1514	-111.7229
41.1067	-111.7067
41.0766	-111.6722
41.0273	-111.6687
41.0096	-111.6553

------ End Nested Sources for Morgan fault [2353abc] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

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Name: West Valley fault [2386]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forWest Valley fault [2386] -------
Name: 2386 West Valley fault (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.02000000
Deterministic Magnitude: 6.5

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.1	Activity	4.481e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.300000	Activity	4.481e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.100000	Activity	4.481e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.100000	Activity	6.360e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.300000	Activity	6.360e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.100000	Activity	6.360e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6580	-111.9508
40.6701	-111.9538
40.6881	-111.9588
40.7000	-111.9668
40.7171	-111.9728
40.7341	-111.9888
40.7451	-111.9888
40.7971	-112.0178

Name: 2386 West Valley fault (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.06000000
Deterministic Magnitude: 6.5

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.1	Activity	4.481e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.300000	Activity	4.481e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.100000	Activity	4.481e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.100000	Activity	6.360e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.300000	Activity	6.360e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.100000	Activity	6.360e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6580	-111.9508
40.6701	-111.9538
40.6881	-111.9588
40.7000	-111.9668
40.7171	-111.9728
40.7341	-111.9888
40.7451	-111.9888
40.7971	-112.0178

Name: 2386 West Valley fault (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.02000000
Deterministic Magnitude: 6.5

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.1	Activity	4.481e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.300000	Activity	4.481e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.100000	Activity	4.481e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.100000	Activity	6.360e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.300000	Activity	6.360e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.100000	Activity	6.360e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6580	-111.9508
40.6701	-111.9538
40.6881	-111.9588
40.7000	-111.9668
40.7171	-111.9728
40.7341	-111.9888
40.7451	-111.9888
40.7971	-112.0178

------ End Nested Sources for West Valley fault [2386] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

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Name: W65G35 West Valley (Wasatch 65) fault (dip 35)
Region: USGS 2014 Utah
Category:Fault
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.03200000
Deterministic Magnitude: 6.5

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	6.017

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	3.597e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.600000	Activity	3.597e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.200000	Activity	3.597e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6580	-111.9500

```
    40.6700  -111.9530
    40.6880  -111.9580
    40.7000  -111.9660
    40.7170  -111.9720
    40.7340  -111.9880
    40.7450  -111.9880
    40.7970  -112.0170

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
      0.25      0.250000          Abrahamson-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Boore-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

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Name: W50G35 West Valley (Wasatch 50) fault (dip 35)
Region: USGS 2014 Utah
Category:Fault
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.09600000
Deterministic Magnitude: 6.5

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        35         0     0.001     5.033

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal       0.2    Activity  3.597e-004  6.060000  6.540000  2.300000  6.300000  0.120000  0.010000 10.000000
           Normal  0.600000    Activity  3.597e-004  6.260000  6.740000  2.300000  6.500000  0.120000  0.010000 10.000000
           Normal  0.200000    Activity  3.597e-004  6.460000  6.940000  2.300000  6.700000  0.120000  0.010000 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw      Sigw        Aa        Ba      Sigw
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    40.6580  -111.9500
    40.6700  -111.9530
    40.6880  -111.9580
    40.7000  -111.9660
    40.7170  -111.9720
    40.7340  -111.9880
    40.7450  -111.9880
    40.7970  -112.0170

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
      0.25      0.250000          Abrahamson-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Boore-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

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Name: W35G35 West Valley (Wasatch 35) fault (dip 35)
Region: USGS 2014 Utah
Category:Fault
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.03200000
Deterministic Magnitude: 6.5

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        35         0     0.001     3.991

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal       0.2    Activity  3.597e-004  6.060000  6.540000  2.300000  6.300000  0.120000  0.010000 10.000000
           Normal  0.600000    Activity  3.597e-004  6.260000  6.740000  2.300000  6.500000  0.120000  0.010000 10.000000
           Normal  0.200000    Activity  3.597e-004  6.460000  6.940000  2.300000  6.700000  0.120000  0.010000 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw      Sigw        Aa        Ba      Sigw
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    40.6580  -111.9500
```

```
    40.6700  -111.9530
    40.6880  -111.9580
    40.7000  -111.9660
    40.7170  -111.9720
    40.7340  -111.9880
    40.7450  -111.9880
    40.7970  -112.0170

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
      0.25      0.250000          Abrahamson-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Boore-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

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Name: W65G50 West Valley (Wasatch 65) fault (dip 50)
Region: USGS 2014 Utah
Category:Fault
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.09600000
Deterministic Magnitude: 6.5

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        50         0     0.001     8.733

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal       0.2    Activity  3.597e-004  6.060000  6.540000  2.300000  6.300000  0.120000  0.010000 10.000000
           Normal  0.600000    Activity  3.597e-004  6.260000  6.740000  2.300000  6.500000  0.120000  0.010000 10.000000
           Normal  0.200000    Activity  3.597e-004  6.460000  6.940000  2.300000  6.700000  0.120000  0.010000 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw      Sigw        Aa        Ba      Sigw
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    40.6580  -111.9500
    40.6700  -111.9530
    40.6880  -111.9580
    40.7000  -111.9660
    40.7170  -111.9720
    40.7340  -111.9880
    40.7450  -111.9880
    40.7970  -112.0170

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
      0.25      0.250000          Abrahamson-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Boore-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

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Name: W50G50 West Valley (Wasatch 50) fault (dip 50)
Region: USGS 2014 Utah
Category:Fault
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.28800000
Deterministic Magnitude: 6.5

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        50         0     0.001     6.793

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal       0.2    Activity  3.597e-004  6.060000  6.540000  2.300000  6.300000  0.120000  0.010000 10.000000
           Normal  0.600000    Activity  3.597e-004  6.260000  6.740000  2.300000  6.500000  0.120000  0.010000 10.000000
           Normal  0.200000    Activity  3.597e-004  6.460000  6.940000  2.300000  6.700000  0.120000  0.010000 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw      Sigw        Aa        Ba      Sigw
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    40.6580  -111.9500
```

40.6700	-111.9530
40.6880	-111.9580
40.7000	-111.9660
40.7170	-111.9720
40.7340	-111.9880
40.7450	-111.9880
40.7970	-112.0170

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

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Name: W35G50 West Valley (Wasatch 35) fault (dip 50)
Region: USGS 2014 Utah
Category:Fault
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.09600000
Deterministic Magnitude: 6.5

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	5.028

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	3.597e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.600000	Activity	3.597e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.200000	Activity	3.597e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6580	-111.9500
40.6700	-111.9530
40.6880	-111.9580
40.7000	-111.9660
40.7170	-111.9720
40.7340	-111.9880
40.7450	-111.9880
40.7970	-112.0170

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: W50G65 West Valley (Wasatch 50) fault (dip 65)
Region: USGS 2014 Utah
Category:Fault
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.09600000
Deterministic Magnitude: 6.5

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	8.733

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	3.597e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.600000	Activity	3.597e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.200000	Activity	3.597e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6580	-111.9500

40.6700	-111.9530
40.6880	-111.9580
40.7000	-111.9660
40.7170	-111.9720
40.7340	-111.9880
40.7450	-111.9880
40.7970	-112.0170

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: W65G65 West Valley (Wasatch 65) fault (dip 65)
Region: USGS 2014 Utah
Category:Fault
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.03200000
Deterministic Magnitude: 6.5

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	12.22

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	3.597e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.600000	Activity	3.597e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.200000	Activity	3.597e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6580	-111.9500
40.6700	-111.9530
40.6880	-111.9580
40.7000	-111.9660
40.7170	-111.9720
40.7340	-111.9880
40.7450	-111.9880
40.7970	-112.0170

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: W35G65 West Valley (Wasatch 35) fault (dip 65)
Region: USGS 2014 Utah
Category:Fault
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.03200000
Deterministic Magnitude: 6.5

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	6.018

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.2	Activity	3.597e-004	6.060000	6.540000	2.300000	6.300000	0.120000	0.010000	10.000000
Normal	0.600000	Activity	3.597e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.200000	Activity	3.597e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6580	-111.9500

40.6700	-111.9530
40.6880	-111.9580
40.7000	-111.9660
40.7170	-111.9720
40.7340	-111.9880
40.7450	-111.9880
40.7970	-112.0170

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Great Salt Lake fault zone, Antelope Island [2369c]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forGreat Salt Lake fault zone, Antelope Island [2369c] -------
Name: 2369c Great Salt Lake fault zone, Antelope Island (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.93

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.215e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.890000	7.370000	2.300000	7.130000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	3.180e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	5.038e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	6.323e-004	6.500000	7.130000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.215e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.215e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.215e-004	6.890000	7.370000	2.300000	7.130000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	3.180e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	5.038e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	6.323e-004	6.500000	7.130000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.215e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.890000	7.370000	2.300000	7.130000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	3.180e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	5.038e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	6.323e-004	6.500000	7.130000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.0344	-112.3197
41.0122	-112.3019
40.9891	-112.2656
40.9661	-112.2723
40.9444	-112.2699
40.8702	-112.2372
40.8545	-112.2170
40.8191	-112.1844
40.7938	-112.1956
40.7505	-112.2043

40.7340	-112.2145
40.7239	-112.2305

Name: 2369c Great Salt Lake fault zone, Antelope Island (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.93

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.215e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.890000	7.370000	2.300000	7.130000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	3.180e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	5.038e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	6.323e-004	6.500000	7.130000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.215e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.215e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.215e-004	6.890000	7.370000	2.300000	7.130000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	3.180e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	5.038e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	6.323e-004	6.500000	7.130000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.215e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.890000	7.370000	2.300000	7.130000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	3.180e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	5.038e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	6.323e-004	6.500000	7.130000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.0344	-112.3197
41.0122	-112.3019
40.9891	-112.2656
40.9661	-112.2723
40.9444	-112.2699
40.8702	-112.2372
40.8545	-112.2170
40.8191	-112.1844
40.7938	-112.1956
40.7505	-112.2043
40.7340	-112.2145
40.7239	-112.2305

Name: 2369c Great Salt Lake fault zone, Antelope Island (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.93

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.215e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.890000	7.370000	2.300000	7.130000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	3.180e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000

Exponential	0.019998	Activity	5.038e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	6.323e-004	6.500000	7.130000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.215e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.215e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.215e-004	6.890000	7.370000	2.300000	7.130000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	3.180e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	5.038e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	6.323e-004	6.500000	7.130000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.215e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.890000	7.370000	2.300000	7.130000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	3.180e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	5.038e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	6.323e-004	6.500000	7.130000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.0344	-112.3197
41.0122	-112.3019
40.9891	-112.2656
40.9661	-112.2723
40.9444	-112.2699
40.8702	-112.2372
40.8545	-112.2170
40.8191	-112.1844
40.7938	-112.1956
40.7505	-112.2043
40.7340	-112.2145
40.7239	-112.2305

------ End Nested Sources for Great Salt Lake fault zone, Antelope Island [2369c] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Great Salt Lake fault zone, Fremont Island s [2369b]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forGreat Salt Lake fault zone, Fremont Island s [2369b] -------
Name: 2369b Great Salt Lake fault zone, Fremont Island s (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.83

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.215e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.976e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.226e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.783e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.215e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000

Normal	0.319998	Activity	2.215e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.215e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.976e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	4.226e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	5.783e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.215e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.976e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.226e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.783e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.2100	-112.5219
41.1992	-112.5202
41.1783	-112.4922
41.1713	-112.4527
41.1616	-112.4409
41.1515	-112.4141
41.0932	-112.3645
41.0601	-112.3545
41.0260	-112.3274
41.0036	-112.3192
40.9927	-112.3061

Name: 2369b Great Salt Lake fault zone, Fremont Island s (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.83

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.215e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.976e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.226e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.783e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.215e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.215e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.215e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.976e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	4.226e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	5.783e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.215e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.976e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.226e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.783e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.2100	-112.5219
41.1992	-112.5202
41.1783	-112.4922
41.1713	-112.4527
41.1616	-112.4409
41.1515	-112.4141
41.0932	-112.3645
41.0601	-112.3545
41.0260	-112.3274
41.0036	-112.3192
40.9927	-112.3061

Name: 2369b Great Salt Lake fault zone, Fremont Island s (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.83

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.215e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.976e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.226e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.783e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.215e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.215e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.215e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.976e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	4.226e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	5.783e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.215e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.976e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.226e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.783e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.2100	-112.5219
41.1992	-112.5202
41.1783	-112.4922
41.1713	-112.4527
41.1616	-112.4409
41.1515	-112.4141
41.0932	-112.3645
41.0601	-112.3545
41.0260	-112.3274

```
    41.0036  -112.3192
    40.9927  -112.3061

 ------ End Nested Sources for Great Salt Lake fault zone, Fremont Island s [2369b] -------

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
      0.25      0.250000          Abrahamson-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Boore-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

*****************************************

Name: Wasatch fault, Brigham City section [2351d]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
 ------ Start Nested Sources forWasatch fault, Brigham City section [2351d] -------
Name: 2351d Wasatch fault, Brigham City section (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 6.95

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        35         0     0.001        15

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal 0.0160008    Activity  8.460e-004  6.510000  6.990000  2.300000  6.750000  0.120000  0.010000 10.000000
           Normal  0.048002    Activity  8.460e-004  6.710000  7.190000  2.300000  6.950000  0.120000  0.010000 10.000000
           Normal  0.016001    Activity  8.460e-004  6.910000  7.390000  2.300000  7.150000  0.120000  0.010000 10.000000
      Exponential  0.004000    Activity  1.305e-003  6.500000  6.750000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.011999    Activity  1.993e-003  6.500000  6.950000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.004000    Activity  2.469e-003  6.500000  7.150000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.127999    Activity  8.460e-004  6.510000  6.990000  2.300000  6.750000  0.120000  0.010000 10.000000
           Normal  0.383997    Activity  8.460e-004  6.710000  7.190000  2.300000  6.950000  0.120000  0.010000 10.000000
           Normal  0.127999    Activity  8.460e-004  6.910000  7.390000  2.300000  7.150000  0.120000  0.010000 10.000000
      Exponential  0.032000    Activity  1.305e-003  6.500000  6.750000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.096001    Activity  1.993e-003  6.500000  6.950000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.032000    Activity  2.469e-003  6.500000  7.150000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.016001    Activity  8.460e-004  6.510000  6.990000  2.300000  6.750000  0.120000  0.010000 10.000000
           Normal  0.048002    Activity  8.460e-004  6.710000  7.190000  2.300000  6.950000  0.120000  0.010000 10.000000
           Normal  0.016001    Activity  8.460e-004  6.910000  7.390000  2.300000  7.150000  0.120000  0.010000 10.000000
      Exponential  0.004000    Activity  1.305e-003  6.500000  6.750000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.011999    Activity  1.993e-003  6.500000  6.950000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.004000    Activity  2.469e-003  6.500000  7.150000  1.842068  0.000000  0.000000  0.000000  0.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw      Sigw        Aa        Ba      Sigw
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    41.6521  -112.0483
    41.6404  -112.0607
    41.6306  -112.0553
    41.6164  -112.0561
    41.6106  -112.0420
    41.5602  -112.0179
    41.5542  -112.0199
    41.5235  -111.9987
    41.4992  -111.9887
    41.4436  -112.0293
    41.4277  -112.0290
    41.4166  -112.0217
    41.3807  -112.0254
```

41.3589	-111.9886
41.3333	-111.9614

Name: 2351d Wasatch fault, Brigham City section (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.54000108
Deterministic Magnitude: 6.95

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	8.460e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	8.460e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	8.460e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.305e-003	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	1.993e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	2.469e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	8.460e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	8.460e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	8.460e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	1.305e-003	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	1.993e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	2.469e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	8.460e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	8.460e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	8.460e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.305e-003	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	1.993e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	2.469e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6521	-112.0483
41.6404	-112.0607
41.6306	-112.0553
41.6164	-112.0561
41.6106	-112.0420
41.5602	-112.0179
41.5542	-112.0199
41.5235	-111.9987
41.4992	-111.9887
41.4436	-112.0293
41.4277	-112.0290
41.4166	-112.0217
41.3807	-112.0254
41.3589	-111.9886
41.3333	-111.9614

Name: 2351d Wasatch fault, Brigham City section (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 6.95

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	8.460e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000

Normal	0.048002	Activity	8.460e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	8.460e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.305e-003	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	1.993e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	2.469e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	8.460e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	8.460e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	8.460e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	1.305e-003	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	1.993e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	2.469e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	8.460e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	8.460e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	8.460e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.305e-003	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	1.993e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	2.469e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6521	-112.0483
41.6404	-112.0607
41.6306	-112.0553
41.6164	-112.0561
41.6106	-112.0420
41.5602	-112.0179
41.5542	-112.0199
41.5235	-111.9987
41.4992	-111.9887
41.4436	-112.0293
41.4277	-112.0290
41.4166	-112.0217
41.3807	-112.0254
41.3589	-111.9886
41.3333	-111.9614

------ End Nested Sources for Wasatch fault, Brigham City section [2351d] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Oquirrh-Southern Oquirrh Mountains fault [2398_2399]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forOquirrh-Southern Oquirrh Mountains fault [2398_2399] -------
Name: 2398_2399 Oquirrh-Southern Oquirrh Mountains fault (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.17

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.414e-004	6.730000	7.210000	2.300000	6.970000	0.120000	0.010000	10.000000

Normal	0.040002	Activity	1.414e-004	6.930000	7.410000	2.300000	7.170000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.414e-004	7.130000	7.610000	2.300000	7.370000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	4.010e-004	6.500000	6.970000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.907e-004	6.500000	7.170000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.528e-004	6.500000	7.370000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.419e-004	6.730000	7.210000	2.300000	6.970000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.419e-004	6.930000	7.410000	2.300000	7.170000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.419e-004	7.130000	7.610000	2.300000	7.370000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	4.026e-004	6.500000	6.970000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	4.927e-004	6.500000	7.170000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	5.551e-004	6.500000	7.370000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.794e-004	6.730000	7.210000	2.300000	6.970000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.794e-004	6.930000	7.410000	2.300000	7.170000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.794e-004	7.130000	7.610000	2.300000	7.370000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.089e-004	6.500000	6.970000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.228e-004	6.500000	7.170000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.016e-004	6.500000	7.370000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6947	-112.2540
40.6861	-112.2474
40.6529	-112.2449
40.6496	-112.2553
40.6411	-112.2570
40.6379	-112.2638
40.6314	-112.2596
40.6046	-112.2578
40.5554	-112.2011
40.5443	-112.2011
40.5352	-112.2398
40.5177	-112.2586
40.5007	-112.3051
40.4598	-112.3455
40.4019	-112.3177
40.3090	-112.2756
40.2705	-112.2590
40.2288	-112.2239

Name: 2398_2399 Oquirrh-Southern Oquirrh Mountains fault (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 7.17

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.414e-004	6.730000	7.210000	2.300000	6.970000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.414e-004	6.930000	7.410000	2.300000	7.170000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.414e-004	7.130000	7.610000	2.300000	7.370000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	4.010e-004	6.500000	6.970000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.907e-004	6.500000	7.170000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.528e-004	6.500000	7.370000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.419e-004	6.730000	7.210000	2.300000	6.970000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.419e-004	6.930000	7.410000	2.300000	7.170000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.419e-004	7.130000	7.610000	2.300000	7.370000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	4.026e-004	6.500000	6.970000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	4.927e-004	6.500000	7.170000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	5.551e-004	6.500000	7.370000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.794e-004	6.730000	7.210000	2.300000	6.970000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.794e-004	6.930000	7.410000	2.300000	7.170000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.794e-004	7.130000	7.610000	2.300000	7.370000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.089e-004	6.500000	6.970000	1.842068	0.000000	0.000000	0.000000	0.000000

Exponential	0.019998	Activity	6.228e-004	6.500000	7.170000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.016e-004	6.500000	7.370000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6947	-112.2540
40.6861	-112.2474
40.6529	-112.2449
40.6496	-112.2553
40.6411	-112.2570
40.6379	-112.2638
40.6314	-112.2596
40.6046	-112.2578
40.5554	-112.2011
40.5443	-112.2011
40.5352	-112.2398
40.5177	-112.2586
40.5007	-112.3051
40.4598	-112.3455
40.4019	-112.3177
40.3090	-112.2756
40.2705	-112.2590
40.2288	-112.2239

Name: 2398_2399 Oquirrh-Southern Oquirrh Mountains fault (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.17

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.414e-004	6.730000	7.210000	2.300000	6.970000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.414e-004	6.930000	7.410000	2.300000	7.170000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.414e-004	7.130000	7.610000	2.300000	7.370000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	4.010e-004	6.500000	6.970000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.907e-004	6.500000	7.170000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.528e-004	6.500000	7.370000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.419e-004	6.730000	7.210000	2.300000	6.970000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.419e-004	6.930000	7.410000	2.300000	7.170000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.419e-004	7.130000	7.610000	2.300000	7.370000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	4.026e-004	6.500000	6.970000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	4.927e-004	6.500000	7.170000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	5.551e-004	6.500000	7.370000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.794e-004	6.730000	7.210000	2.300000	6.970000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.794e-004	6.930000	7.410000	2.300000	7.170000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.794e-004	7.130000	7.610000	2.300000	7.370000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.089e-004	6.500000	6.970000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.228e-004	6.500000	7.170000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.016e-004	6.500000	7.370000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6947	-112.2540
40.6861	-112.2474
40.6529	-112.2449
40.6496	-112.2553
40.6411	-112.2570
40.6379	-112.2638
40.6314	-112.2596
40.6046	-112.2578
40.5554	-112.2011
40.5443	-112.2011
40.5352	-112.2398
40.5177	-112.2586
40.5007	-112.3051
40.4598	-112.3455
40.4019	-112.3177
40.3090	-112.2756
40.2705	-112.2590
40.2288	-112.2239

------ End Nested Sources for Oquirrh-Southern Oquirrh Mountains fault [2398_2399] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: East Cache fault zone [2352abc]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forEast Cache fault zone [2352abc] -------
Name: 2352abc East Cache fault zone (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.31

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.537e-004	6.870000	7.350000	2.300000	7.110000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.537e-004	7.070000	7.550000	2.300000	7.310000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.537e-004	7.270000	7.750000	2.300000	7.510000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.955e-004	6.500000	7.110000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.839e-004	6.500000	7.310000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.450e-004	6.500000	7.510000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.146e-004	6.870000	7.350000	2.300000	7.110000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.146e-004	7.070000	7.550000	2.300000	7.310000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.146e-004	7.270000	7.750000	2.300000	7.510000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	4.442e-004	6.500000	7.110000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	5.101e-004	6.500000	7.310000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	5.557e-004	6.500000	7.510000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.229e-004	6.870000	7.350000	2.300000	7.110000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.229e-004	7.070000	7.550000	2.300000	7.310000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.229e-004	7.270000	7.750000	2.300000	7.510000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	4.764e-004	6.500000	7.110000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	5.471e-004	6.500000	7.310000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.960e-004	6.500000	7.510000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
42.1322	-111.6970
42.0494	-111.7307
42.0006	-111.7371
41.9750	-111.7633
41.9328	-111.7882
41.9140	-111.7946
41.9094	-111.7904
41.8948	-111.7919
41.8801	-111.8031
41.8757	-111.8154
41.8311	-111.7915
41.7802	-111.7761
41.7435	-111.7917
41.6407	-111.8064
41.6172	-111.7998
41.5942	-111.7844
41.4999	-111.7761
41.4475	-111.7604
41.4208	-111.7646

Name: 2352abc East Cache fault zone (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 7.31

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.537e-004	6.870000	7.350000	2.300000	7.110000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.537e-004	7.070000	7.550000	2.300000	7.310000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.537e-004	7.270000	7.750000	2.300000	7.510000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.955e-004	6.500000	7.110000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.839e-004	6.500000	7.310000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.450e-004	6.500000	7.510000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.146e-004	6.870000	7.350000	2.300000	7.110000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.146e-004	7.070000	7.550000	2.300000	7.310000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.146e-004	7.270000	7.750000	2.300000	7.510000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	4.442e-004	6.500000	7.110000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	5.101e-004	6.500000	7.310000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	5.557e-004	6.500000	7.510000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.229e-004	6.870000	7.350000	2.300000	7.110000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.229e-004	7.070000	7.550000	2.300000	7.310000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.229e-004	7.270000	7.750000	2.300000	7.510000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	4.764e-004	6.500000	7.110000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	5.471e-004	6.500000	7.310000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.960e-004	6.500000	7.510000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude

42.1322	-111.6970
42.0494	-111.7307
42.0006	-111.7371
41.9750	-111.7633
41.9328	-111.7882
41.9140	-111.7946
41.9094	-111.7904
41.8948	-111.7919
41.8801	-111.8031
41.8757	-111.8154
41.8311	-111.7915
41.7802	-111.7761
41.7435	-111.7917
41.6407	-111.8064
41.6172	-111.7998
41.5942	-111.7844
41.4999	-111.7761
41.4475	-111.7604
41.4208	-111.7646

Name: 2352abc East Cache fault zone (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.31

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.537e-004	6.870000	7.350000	2.300000	7.110000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.537e-004	7.070000	7.550000	2.300000	7.310000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.537e-004	7.270000	7.750000	2.300000	7.510000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.955e-004	6.500000	7.110000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.839e-004	6.500000	7.310000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.450e-004	6.500000	7.510000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.146e-004	6.870000	7.350000	2.300000	7.110000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.146e-004	7.070000	7.550000	2.300000	7.310000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.146e-004	7.270000	7.750000	2.300000	7.510000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	4.442e-004	6.500000	7.110000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	5.101e-004	6.500000	7.310000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	5.557e-004	6.500000	7.510000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.229e-004	6.870000	7.350000	2.300000	7.110000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.229e-004	7.070000	7.550000	2.300000	7.310000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.229e-004	7.270000	7.750000	2.300000	7.510000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	4.764e-004	6.500000	7.110000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	5.471e-004	6.500000	7.310000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.960e-004	6.500000	7.510000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
42.1322	-111.6970
42.0494	-111.7307
42.0006	-111.7371
41.9750	-111.7633
41.9328	-111.7882
41.9140	-111.7946
41.9094	-111.7904
41.8948	-111.7919
41.8801	-111.8031
41.8757	-111.8154
41.8311	-111.7915
41.7802	-111.7761
41.7435	-111.7917
41.6407	-111.8064

41.6172	-111.7998
41.5942	-111.7844
41.4999	-111.7761
41.4475	-111.7604
41.4208	-111.7646

------ End Nested Sources for East Cache fault zone [2352abc] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Great Salt Lake fault zone, Promontory secti [2369a]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forGreat Salt Lake fault zone, Promontory secti [2369a] -------
Name: 2369a Great Salt Lake fault zone, Promontory secti (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.09

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.215e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.164e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.677e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.725e-004	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.215e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.215e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.215e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	5.164e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	6.677e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	7.725e-004	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.215e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.164e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.677e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.725e-004	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.5341	-112.8363
41.4934	-112.8040
41.4674	-112.7756
41.4357	-112.7050
41.3982	-112.6553
41.3881	-112.5763
41.3755	-112.5474
41.3464	-112.5337
41.3244	-112.5135
41.2631	-112.5126

41.2369	-112.5029
41.2149	-112.4902
41.1918	-112.4588

Name: 2369a Great Salt Lake fault zone, Promontory secti (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 7.09

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.215e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.164e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.677e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.725e-004	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.215e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.215e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.215e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	5.164e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	6.677e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	7.725e-004	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.215e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.164e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.677e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.725e-004	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.5341	-112.8363
41.4934	-112.8040
41.4674	-112.7756
41.4357	-112.7050
41.3982	-112.6553
41.3881	-112.5763
41.3755	-112.5474
41.3464	-112.5337
41.3244	-112.5135
41.2631	-112.5126
41.2369	-112.5029
41.2149	-112.4902
41.1918	-112.4588

Name: 2369a Great Salt Lake fault zone, Promontory secti (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.09

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.215e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000

Normal	0.013334	Activity	2.215e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.164e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.677e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.725e-004	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.215e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.215e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.215e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	5.164e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	6.677e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	7.725e-004	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.215e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.215e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.215e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.164e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	6.677e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	7.725e-004	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.5341	-112.8363
41.4934	-112.8040
41.4674	-112.7756
41.4357	-112.7050
41.3982	-112.6553
41.3881	-112.5763
41.3755	-112.5474
41.3464	-112.5337
41.3244	-112.5135
41.2631	-112.5126
41.2369	-112.5029
41.2149	-112.4902
41.1918	-112.4588

------ End Nested Sources for Great Salt Lake fault zone, Promontory secti [2369a] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Wasatch fault, Provo section [2351g]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forWasatch fault, Provo section [2351g] -------
Name: 2351g Wasatch fault, Provo section (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 7.27

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	7.157e-004	6.830000	7.310000	2.300000	7.070000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	7.157e-004	7.030000	7.510000	2.300000	7.270000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.230000	7.710000	2.300000	7.470000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	2.545e-003	6.500000	7.070000	1.842068	0.000000	0.000000	0.000000	0.000000

Exponential	0.011999	Activity	2.967e-003	6.500000	7.270000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.260e-003	6.500000	7.470000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	7.157e-004	6.830000	7.310000	2.300000	7.070000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	7.157e-004	7.030000	7.510000	2.300000	7.270000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	7.157e-004	7.230000	7.710000	2.300000	7.470000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	2.545e-003	6.500000	7.070000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	2.967e-003	6.500000	7.270000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	3.260e-003	6.500000	7.470000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	7.157e-004	6.830000	7.310000	2.300000	7.070000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	7.157e-004	7.030000	7.510000	2.300000	7.270000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.230000	7.710000	2.300000	7.470000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	2.545e-003	6.500000	7.070000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.967e-003	6.500000	7.270000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.260e-003	6.500000	7.470000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.4950	-111.8217
40.4857	-111.7538
40.4812	-111.7467
40.4760	-111.7445
40.4602	-111.7506
40.4554	-111.7463
40.4448	-111.7533
40.4343	-111.7531
40.4152	-111.7418
40.4110	-111.7436
40.3977	-111.7275
40.3845	-111.7206
40.3538	-111.6916
40.3418	-111.6761
40.3131	-111.6569
40.3119	-111.6384
40.2877	-111.6321
40.2780	-111.6353
40.2344	-111.6316
40.2122	-111.6240
40.2092	-111.6170
40.1946	-111.6092
40.1895	-111.5991
40.1726	-111.5971
40.1671	-111.5816
40.1489	-111.5558
40.1330	-111.5508
40.1273	-111.5583
40.1212	-111.5559
40.1005	-111.5717
40.0842	-111.5727
40.0716	-111.6188
40.0486	-111.6353
40.0325	-111.6314
40.0062	-111.6436
39.9865	-111.6893
39.9716	-111.6933

Name: 2351g Wasatch fault, Provo section (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.54000108
Deterministic Magnitude: 7.27

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2

Normal	0.0160008	Activity	7.157e-004	6.830000	7.310000	2.300000	7.070000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	7.157e-004	7.030000	7.510000	2.300000	7.270000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.230000	7.710000	2.300000	7.470000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	2.545e-003	6.500000	7.070000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.967e-003	6.500000	7.270000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.260e-003	6.500000	7.470000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	7.157e-004	6.830000	7.310000	2.300000	7.070000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	7.157e-004	7.030000	7.510000	2.300000	7.270000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	7.157e-004	7.230000	7.710000	2.300000	7.470000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	2.545e-003	6.500000	7.070000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	2.967e-003	6.500000	7.270000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	3.260e-003	6.500000	7.470000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	7.157e-004	6.830000	7.310000	2.300000	7.070000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	7.157e-004	7.030000	7.510000	2.300000	7.270000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.230000	7.710000	2.300000	7.470000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	2.545e-003	6.500000	7.070000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.967e-003	6.500000	7.270000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.260e-003	6.500000	7.470000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.4950	-111.8217
40.4857	-111.7538
40.4812	-111.7467
40.4760	-111.7445
40.4602	-111.7506
40.4554	-111.7463
40.4448	-111.7533
40.4343	-111.7531
40.4152	-111.7418
40.4110	-111.7436
40.3977	-111.7275
40.3845	-111.7206
40.3538	-111.6916
40.3418	-111.6761
40.3131	-111.6569
40.3119	-111.6384
40.2877	-111.6321
40.2780	-111.6353
40.2344	-111.6316
40.2122	-111.6240
40.2092	-111.6170
40.1946	-111.6092
40.1895	-111.5991
40.1726	-111.5971
40.1671	-111.5816
40.1489	-111.5558
40.1330	-111.5508
40.1273	-111.5583
40.1212	-111.5559
40.1005	-111.5717
40.0842	-111.5727
40.0716	-111.6188
40.0486	-111.6353
40.0325	-111.6314
40.0062	-111.6436
39.9865	-111.6893
39.9716	-111.6933

Name: 2351g Wasatch fault, Provo section (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 7.27

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3

90	65	0	0.001	15						

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	7.157e-004	6.830000	7.310000	2.300000	7.070000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	7.157e-004	7.030000	7.510000	2.300000	7.270000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.230000	7.710000	2.300000	7.470000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	2.545e-003	6.500000	7.070000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.967e-003	6.500000	7.270000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.260e-003	6.500000	7.470000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	7.157e-004	6.830000	7.310000	2.300000	7.070000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	7.157e-004	7.030000	7.510000	2.300000	7.270000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	7.157e-004	7.230000	7.710000	2.300000	7.470000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	2.545e-003	6.500000	7.070000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	2.967e-003	6.500000	7.270000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	3.260e-003	6.500000	7.470000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	7.157e-004	6.830000	7.310000	2.300000	7.070000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	7.157e-004	7.030000	7.510000	2.300000	7.270000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	7.157e-004	7.230000	7.710000	2.300000	7.470000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	2.545e-003	6.500000	7.070000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.967e-003	6.500000	7.270000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.260e-003	6.500000	7.470000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.4950	-111.8217
40.4857	-111.7538
40.4812	-111.7467
40.4760	-111.7445
40.4602	-111.7506
40.4554	-111.7463
40.4448	-111.7533
40.4343	-111.7531
40.4152	-111.7418
40.4110	-111.7436
40.3977	-111.7275
40.3845	-111.7206
40.3538	-111.6916
40.3418	-111.6761
40.3131	-111.6569
40.3119	-111.6384
40.2877	-111.6321
40.2780	-111.6353
40.2344	-111.6316
40.2122	-111.6240
40.2092	-111.6170
40.1946	-111.6092
40.1895	-111.5991
40.1726	-111.5971
40.1671	-111.5816
40.1489	-111.5558
40.1330	-111.5508
40.1273	-111.5583
40.1212	-111.5559
40.1005	-111.5717
40.0842	-111.5727
40.0716	-111.6188
40.0486	-111.6353
40.0325	-111.6314
40.0062	-111.6436
39.9865	-111.6893
39.9716	-111.6933

------ End Nested Sources for Wasatch fault, Provo section [2351g] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014

```
      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

*****************************************

Name: West Cache fault, Wellsville section [2521c]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
 ------ Start Nested Sources forWest Cache fault, Wellsville section [2521c] -------
Name: 2521c West Cache fault, Wellsville section (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.6

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        35         0     0.001        15

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal  0.013334    Activity  8.896e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.040002    Activity  8.896e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.013334    Activity  8.896e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.033330    Activity  1.138e-003  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.106666    Activity  1.635e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.319998    Activity  1.635e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.106666    Activity  1.635e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.266670    Activity  2.091e-004  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.013334    Activity  1.879e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.040002    Activity  1.879e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.013334    Activity  1.879e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.033330    Activity  2.403e-004  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw      Sigw        Aa        Ba      Sigw
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    41.5797  -111.8761
    41.6012  -111.9189
    41.6249  -111.9523
    41.6897  -112.0002
    41.6966  -112.0106
    41.7210  -112.0237

Name: 2521c West Cache fault, Wellsville section (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.6

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        50         0     0.001        15

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal  0.013334    Activity  8.896e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.040002    Activity  8.896e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.013334    Activity  8.896e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.033330    Activity  1.138e-003  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.106666    Activity  1.635e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.319998    Activity  1.635e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.106666    Activity  1.635e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.266670    Activity  2.091e-004  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.013334    Activity  1.879e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.040002    Activity  1.879e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.013334    Activity  1.879e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.033330    Activity  2.403e-004  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000
```

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.5797	-111.8761
41.6012	-111.9189
41.6249	-111.9523
41.6897	-112.0002
41.6966	-112.0106
41.7210	-112.0237

Name: 2521c West Cache fault, Wellsville section (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.6

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	8.896e-004	6.160000	6.640000	2.300000	6.400000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	8.896e-004	6.360000	6.840000	2.300000	6.600000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	8.896e-004	6.560000	7.040000	2.300000	6.800000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	1.138e-003	6.500000	6.600000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.635e-004	6.160000	6.640000	2.300000	6.400000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.635e-004	6.360000	6.840000	2.300000	6.600000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.635e-004	6.560000	7.040000	2.300000	6.800000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	2.091e-004	6.500000	6.600000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.879e-004	6.160000	6.640000	2.300000	6.400000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.879e-004	6.360000	6.840000	2.300000	6.600000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.879e-004	6.560000	7.040000	2.300000	6.800000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	2.403e-004	6.500000	6.600000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.5797	-111.8761
41.6012	-111.9189
41.6249	-111.9523
41.6897	-112.0002
41.6966	-112.0106
41.7210	-112.0237

------ End Nested Sources for West Cache fault, Wellsville section [2521c] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Stansbury fault zone [2395]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb

Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forStansbury fault zone [2395] -------
Name: 2395 Stansbury fault zone (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.09

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.114e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.114e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.114e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	7.260e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	9.388e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.086e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	3.189e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	3.189e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	3.189e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	7.433e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	9.612e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.112e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	3.603e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.603e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.603e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	8.398e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.086e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.256e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6895	-112.6602
40.5940	-112.6842
40.5422	-112.6720
40.5348	-112.6651
40.5016	-112.6853
40.4755	-112.6931
40.4310	-112.6795
40.4244	-112.6811
40.3946	-112.6658
40.2761	-112.5462
40.2501	-112.5260

Name: 2395 Stansbury fault zone (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 7.09

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.114e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.114e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.114e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	7.260e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	9.388e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000

Exponential	0.006666	Activity	1.086e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	3.189e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	3.189e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	3.189e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	7.433e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	9.612e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.112e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	3.603e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.603e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.603e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	8.398e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.086e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.256e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6895	-112.6602
40.5940	-112.6842
40.5422	-112.6720
40.5348	-112.6651
40.5016	-112.6853
40.4755	-112.6931
40.4310	-112.6795
40.4244	-112.6811
40.3946	-112.6658
40.2761	-112.5462
40.2501	-112.5260

Name: 2395 Stansbury fault zone (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.09

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.114e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.114e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.114e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	7.260e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	9.388e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.086e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	3.189e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	3.189e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	3.189e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	7.433e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	9.612e-004	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.112e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	3.603e-004	6.650000	7.130000	2.300000	6.890000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.603e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.603e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	8.398e-004	6.500000	6.890000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.086e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.256e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.6895	-112.6602
40.5940	-112.6842
40.5422	-112.6720
40.5348	-112.6651
40.5016	-112.6853
40.4755	-112.6931
40.4310	-112.6795
40.4244	-112.6811
40.3946	-112.6658
40.2761	-112.5462
40.2501	-112.5260

------ End Nested Sources for Stansbury fault zone [2395] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Bear River fault zone [730]
Region: USGS 2014 Wyoming
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forBear River fault zone [730] -------
Name: 730 Bear River fault zone (dip 35)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.9

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	4.049e-004	6.460000	6.940000	0.000000	6.700000	0.120000	0.000000	0.000000
Normal	0.040002	Activity	4.049e-004	6.660000	7.140000	0.000000	6.900000	0.120000	0.000000	0.000000
Normal	0.013334	Activity	4.049e-004	6.860000	7.340000	0.000000	7.100000	0.120000	0.000000	0.000000
Exponential	0.006666	Activity	5.163e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	8.735e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.121e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	4.049e-004	6.460000	6.940000	0.000000	6.700000	0.120000	0.000000	0.000000
Normal	0.319998	Activity	4.049e-004	6.660000	7.140000	0.000000	6.900000	0.120000	0.000000	0.000000
Normal	0.106666	Activity	4.049e-004	6.860000	7.340000	0.000000	7.100000	0.120000	0.000000	0.000000
Exponential	0.053334	Activity	5.163e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	8.735e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.121e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	4.049e-004	6.460000	6.940000	0.000000	6.700000	0.120000	0.000000	0.000000
Normal	0.040002	Activity	4.049e-004	6.660000	7.140000	0.000000	6.900000	0.120000	0.000000	0.000000
Normal	0.013334	Activity	4.049e-004	6.860000	7.340000	0.000000	7.100000	0.120000	0.000000	0.000000
Exponential	0.006666	Activity	5.163e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	8.735e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.121e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.1603	-110.7523
41.1343	-110.7642
41.0832	-110.7729
41.0739	-110.7946
41.0515	-110.7939
41.0313	-110.7995
41.0007	-110.7916
40.9898	-110.7983
40.9648	-110.8012
40.9256	-110.7934
40.9174	-110.7997
40.9008	-110.8012
40.8603	-110.7900
40.8445	-110.8045

Name: 730 Bear River fault zone (dip 50)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.9

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	4.049e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.049e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.049e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.163e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	8.735e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.121e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	4.049e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	4.049e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	4.049e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	5.163e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	8.735e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.121e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	4.049e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.049e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.049e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.163e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	8.735e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.121e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.1603	-110.7523
41.1343	-110.7642
41.0832	-110.7729
41.0739	-110.7946
41.0515	-110.7939
41.0313	-110.7995
41.0007	-110.7916
40.9898	-110.7983

40.9648	-110.8012
40.9256	-110.7934
40.9174	-110.7997
40.9008	-110.8012
40.8603	-110.7900
40.8445	-110.8045

Name: 730 Bear River fault zone (dip 65)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.9

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	4.049e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.049e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.049e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.163e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	8.735e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.121e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	4.049e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	4.049e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	4.049e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	5.163e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	8.735e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.121e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	4.049e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.049e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.049e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	5.163e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	8.735e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.121e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.1603	-110.7523
41.1343	-110.7642
41.0832	-110.7729
41.0739	-110.7946
41.0515	-110.7939
41.0313	-110.7995
41.0007	-110.7916
40.9898	-110.7983
40.9648	-110.8012
40.9256	-110.7934
40.9174	-110.7997
40.9008	-110.8012
40.8603	-110.7900
40.8445	-110.8045

------ End Nested Sources for Bear River fault zone [730] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: West Cache fault zone, Junction Hills fault [2521b]

Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forWest Cache fault zone, Junction Hills fault [2521b] -------
Name: 2521b West Cache fault zone, Junction Hills fault (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.7

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.163e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.163e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.163e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	3.291e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.824e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.824e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.824e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	4.296e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.813e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.813e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.813e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	4.279e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6940	-111.9503
41.7139	-111.9681
41.7506	-111.9809
41.7714	-111.9894
41.7853	-111.9942
41.7906	-111.9962
41.7940	-111.9959
41.7941	-111.9959
41.7978	-111.9984
41.8165	-112.0175
41.8497	-112.0452
41.8792	-112.0498
41.8894	-112.0569
41.8958	-112.0655

Name: 2521b West Cache fault zone, Junction Hills fault (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.7

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.163e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.163e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.163e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	3.291e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.824e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.824e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.824e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	4.296e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.813e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.813e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.813e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000

Exponential	0.033330	Activity	4.279e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6940	-111.9503
41.7139	-111.9681
41.7506	-111.9809
41.7714	-111.9894
41.7853	-111.9942
41.7906	-111.9962
41.7940	-111.9959
41.7941	-111.9959
41.7978	-111.9984
41.8165	-112.0175
41.8497	-112.0452
41.8792	-112.0498
41.8894	-112.0569
41.8958	-112.0655

Name: 2521b West Cache fault zone, Junction Hills fault (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.7

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	2.163e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.163e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.163e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	3.291e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.824e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.824e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.824e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	4.296e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.813e-004	6.260000	6.740000	2.300000	6.500000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.813e-004	6.460000	6.940000	2.300000	6.700000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.813e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	4.279e-004	6.500000	6.700000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6940	-111.9503
41.7139	-111.9681
41.7506	-111.9809
41.7714	-111.9894
41.7853	-111.9942
41.7906	-111.9962
41.7940	-111.9959
41.7941	-111.9959
41.7978	-111.9984
41.8165	-112.0175
41.8497	-112.0452
41.8792	-112.0498

```
    41.8894  -112.0569
    41.8958  -112.0655

 ------ End Nested Sources for West Cache fault zone, Junction Hills fault [2521b] -------

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
      0.25      0.250000          Abrahamson-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Boore-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

*****************************************

Name: Hansel Valley fault [2358]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
 ------ Start Nested Sources forHansel Valley fault [2358] -------
Name: 2358 Hansel Valley fault (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.6

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        35         0     0.001        15

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal  0.013334    Activity  1.450e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.040002    Activity  1.450e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.013334    Activity  1.450e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.033330    Activity  1.854e-004  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.106666    Activity  1.262e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.319998    Activity  1.262e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.106666    Activity  1.262e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.266670    Activity  1.614e-004  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.013334    Activity  1.289e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.040002    Activity  1.289e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.013334    Activity  1.289e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.033330    Activity  1.648e-004  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw      Sigw        Aa        Ba      Sigw
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    41.6839  -112.7564
    41.7102  -112.7494
    41.7393  -112.7335
    41.7809  -112.7292
    41.7981  -112.7214

Name: 2358 Hansel Valley fault (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.6

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        50         0     0.001        15

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal  0.013334    Activity  1.450e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
           Normal  0.040002    Activity  1.450e-004  6.360000  6.840000  2.300000  6.600000  0.120000  0.010000 10.000000
           Normal  0.013334    Activity  1.450e-004  6.560000  7.040000  2.300000  6.800000  0.120000  0.010000 10.000000
      Exponential  0.033330    Activity  1.854e-004  6.500000  6.600000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.106666    Activity  1.262e-004  6.160000  6.640000  2.300000  6.400000  0.120000  0.010000 10.000000
```

Normal	0.319998	Activity	1.262e-004	6.360000	6.840000	2.300000	6.600000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.262e-004	6.560000	7.040000	2.300000	6.800000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	1.614e-004	6.500000	6.600000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.289e-004	6.160000	6.640000	2.300000	6.400000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.289e-004	6.360000	6.840000	2.300000	6.600000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.289e-004	6.560000	7.040000	2.300000	6.800000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	1.648e-004	6.500000	6.600000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6839	-112.7564
41.7102	-112.7494
41.7393	-112.7335
41.7809	-112.7292
41.7981	-112.7214

Name: 2358 Hansel Valley fault (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.6

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.450e-004	6.160000	6.640000	2.300000	6.400000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.450e-004	6.360000	6.840000	2.300000	6.600000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.450e-004	6.560000	7.040000	2.300000	6.800000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	1.854e-004	6.500000	6.600000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.262e-004	6.160000	6.640000	2.300000	6.400000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.262e-004	6.360000	6.840000	2.300000	6.600000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.262e-004	6.560000	7.040000	2.300000	6.800000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	1.614e-004	6.500000	6.600000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.289e-004	6.160000	6.640000	2.300000	6.400000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.289e-004	6.360000	6.840000	2.300000	6.600000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.289e-004	6.560000	7.040000	2.300000	6.800000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	1.648e-004	6.500000	6.600000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.6839	-112.7564
41.7102	-112.7494
41.7393	-112.7335
41.7809	-112.7292
41.7981	-112.7214

------ End Nested Sources for Hansel Valley fault [2358] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Eastern Bear Lake fault [2364abc]
Region: USGS 2014 Idaho
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
 ------ Start Nested Sources forEastern Bear Lake fault [2364abc] -------
Name: 2364abc Eastern Bear Lake fault (dip 35)
Region: USGS 2014 Idaho
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.29

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.064e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.064e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.064e-004	7.250000	7.730000	2.300000	7.490000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.138e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.316e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.440e-003	6.500000	7.490000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	3.581e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	3.581e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	3.581e-004	7.250000	7.730000	2.300000	7.490000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.330e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.539e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.683e-003	6.500000	7.490000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.972e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.972e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.972e-004	7.250000	7.730000	2.300000	7.490000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.104e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.277e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.397e-003	6.500000	7.490000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
42.4944	-111.3330
42.4654	-111.3120
42.4182	-111.2997
42.3989	-111.2812
42.3728	-111.2678
42.3473	-111.2694
42.3204	-111.2907
42.2846	-111.2914
42.2664	-111.2891
42.2039	-111.2654
42.1785	-111.2708
42.1537	-111.2631
42.1111	-111.2617
42.0685	-111.2492
42.0003	-111.2590
41.9478	-111.2779
41.8964	-111.2832
41.8756	-111.2947
41.8493	-111.2925
41.8336	-111.3088
41.8205	-111.3143
41.7969	-111.3083

Name: 2364abc Eastern Bear Lake fault (dip 50)
Region: USGS 2014 Idaho

Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 7.29

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.064e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.064e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.064e-004	7.250000	7.730000	2.300000	7.490000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.138e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.316e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.440e-003	6.500000	7.490000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	3.581e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	3.581e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	3.581e-004	7.250000	7.730000	2.300000	7.490000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.330e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.539e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.683e-003	6.500000	7.490000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.972e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.972e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.972e-004	7.250000	7.730000	2.300000	7.490000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.104e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.277e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.397e-003	6.500000	7.490000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
42.4944	-111.3330
42.4654	-111.3120
42.4182	-111.2997
42.3989	-111.2812
42.3728	-111.2678
42.3473	-111.2694
42.3204	-111.2907
42.2846	-111.2914
42.2664	-111.2891
42.2039	-111.2654
42.1785	-111.2708
42.1537	-111.2631
42.1111	-111.2617
42.0685	-111.2492
42.0003	-111.2590
41.9478	-111.2779
41.8964	-111.2832
41.8756	-111.2947
41.8493	-111.2925
41.8336	-111.3088
41.8205	-111.3143
41.7969	-111.3083

Name: 2364abc Eastern Bear Lake fault (dip 65)
Region: USGS 2014 Idaho
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.29

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.064e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.064e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.064e-004	7.250000	7.730000	2.300000	7.490000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.138e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.316e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.440e-003	6.500000	7.490000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	3.581e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	3.581e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	3.581e-004	7.250000	7.730000	2.300000	7.490000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.330e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.539e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.683e-003	6.500000	7.490000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.972e-004	6.850000	7.330000	2.300000	7.090000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.972e-004	7.050000	7.530000	2.300000	7.290000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.972e-004	7.250000	7.730000	2.300000	7.490000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.104e-003	6.500000	7.090000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.277e-003	6.500000	7.290000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.397e-003	6.500000	7.490000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
42.4944	-111.3330
42.4654	-111.3120
42.4182	-111.2997
42.3989	-111.2812
42.3728	-111.2678
42.3473	-111.2694
42.3204	-111.2907
42.2846	-111.2914
42.2664	-111.2891
42.2039	-111.2654
42.1785	-111.2708
42.1537	-111.2631
42.1111	-111.2617
42.0685	-111.2492
42.0003	-111.2590
41.9478	-111.2779
41.8964	-111.2832
41.8756	-111.2947
41.8493	-111.2925
41.8336	-111.3088
41.8205	-111.3143
41.7969	-111.3083

------ End Nested Sources for Eastern Bear Lake fault [2364abc] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

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Name: North Promontory fault [2361]
Region: USGS 2014 Nevada
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forNorth Promontory fault [2361] -------
Name: 2361 North Promontory fault (dip 35)
Region: USGS 2014 Nevada
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000

Deterministic Magnitude: 6.73

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	5.409e-004	6.290000	6.770000	2.300000	6.530000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.409e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.409e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.350e-004	6.500000	6.530000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	8.674e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.374e-003	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.716e-004	6.290000	6.770000	2.300000	6.530000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.716e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.716e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	6.780e-005	6.500000	6.530000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	4.355e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	6.899e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.600e-004	6.290000	6.770000	2.300000	6.530000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.600e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.600e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	6.492e-005	6.500000	6.530000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.170e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	6.606e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.9015	-112.5506
41.8792	-112.5502
41.8545	-112.5571
41.7889	-112.5556
41.7660	-112.5603
41.6991	-112.5944
41.6735	-112.6181

Name: 2361 North Promontory fault (dip 50)
Region: USGS 2014 Nevada
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.73

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	5.409e-004	6.290000	6.770000	2.300000	6.530000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.409e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.409e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.350e-004	6.500000	6.530000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	8.674e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.374e-003	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.716e-004	6.290000	6.770000	2.300000	6.530000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.716e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.716e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	6.780e-005	6.500000	6.530000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	4.355e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	6.899e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.600e-004	6.290000	6.770000	2.300000	6.530000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.600e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.600e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	6.492e-005	6.500000	6.530000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.170e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	6.606e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.9015	-112.5506
41.8792	-112.5502
41.8545	-112.5571
41.7889	-112.5556
41.7660	-112.5603
41.6991	-112.5944
41.6735	-112.6181

Name: 2361 North Promontory fault (dip 65)
Region: USGS 2014 Nevada
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.73

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	5.409e-004	6.290000	6.770000	2.300000	6.530000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.409e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.409e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.350e-004	6.500000	6.530000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	8.674e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.374e-003	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	2.716e-004	6.290000	6.770000	2.300000	6.530000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	2.716e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	2.716e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	6.780e-005	6.500000	6.530000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	4.355e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	6.899e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	2.600e-004	6.290000	6.770000	2.300000	6.530000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	2.600e-004	6.490000	6.970000	2.300000	6.730000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	2.600e-004	6.690000	7.170000	2.300000	6.930000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	6.492e-005	6.500000	6.530000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.170e-004	6.500000	6.730000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	6.606e-004	6.500000	6.930000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.9015	-112.5506
41.8792	-112.5502

41.8545	-112.5571
41.7889	-112.5556
41.7660	-112.5603
41.6991	-112.5944
41.6735	-112.6181

------ End Nested Sources for North Promontory fault [2361] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Strawberry fault [2412]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forStrawberry fault [2412] -------
Name: 2412 Strawberry fault (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.92

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.816e-004	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.816e-004	6.680000	7.160000	2.300000	6.920000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.816e-004	6.880000	7.360000	2.300000	7.120000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	2.510e-004	6.500000	6.720000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.057e-004	6.500000	6.920000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.128e-004	6.500000	7.120000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.030e-004	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.030e-004	6.680000	7.160000	2.300000	6.920000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.030e-004	6.880000	7.360000	2.300000	7.120000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.424e-004	6.500000	6.720000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	2.303e-004	6.500000	6.920000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	2.910e-004	6.500000	7.120000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.027e-004	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.027e-004	6.680000	7.160000	2.300000	6.920000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.027e-004	6.880000	7.360000	2.300000	7.120000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.418e-004	6.500000	6.720000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	2.293e-004	6.500000	6.920000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	2.898e-004	6.500000	7.120000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.2898	-111.2131
40.2892	-111.1854
40.2836	-111.1686
40.2573	-111.1420
40.2520	-111.1082
40.2380	-111.1039
40.2017	-111.1015
40.1678	-111.1149
40.1537	-111.1121
40.1433	-111.1199

Latitude	Longitude
40.1223	-111.1167
40.0904	-111.1429
40.0561	-111.1478
40.0075	-111.1393

Name: 2412 Strawberry fault (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.92

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.816e-004	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.816e-004	6.680000	7.160000	2.300000	6.920000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.816e-004	6.880000	7.360000	2.300000	7.120000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	2.510e-004	6.500000	6.720000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.057e-004	6.500000	6.920000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.128e-004	6.500000	7.120000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.030e-004	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.030e-004	6.680000	7.160000	2.300000	6.920000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.030e-004	6.880000	7.360000	2.300000	7.120000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.424e-004	6.500000	6.720000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	2.303e-004	6.500000	6.920000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	2.910e-004	6.500000	7.120000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.027e-004	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.027e-004	6.680000	7.160000	2.300000	6.920000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.027e-004	6.880000	7.360000	2.300000	7.120000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.418e-004	6.500000	6.720000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	2.293e-004	6.500000	6.920000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	2.898e-004	6.500000	7.120000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.2898	-111.2131
40.2892	-111.1854
40.2836	-111.1686
40.2573	-111.1420
40.2520	-111.1082
40.2380	-111.1039
40.2017	-111.1015
40.1678	-111.1149
40.1537	-111.1121
40.1433	-111.1199
40.1223	-111.1167
40.0904	-111.1429
40.0561	-111.1478
40.0075	-111.1393

Name: 2412 Strawberry fault (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.92

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2

Normal	0.013334	Activity	1.816e-004	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.816e-004	6.680000	7.160000	2.300000	6.920000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.816e-004	6.880000	7.360000	2.300000	7.120000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	2.510e-004	6.500000	6.720000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.057e-004	6.500000	6.920000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.128e-004	6.500000	7.120000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	1.030e-004	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	1.030e-004	6.680000	7.160000	2.300000	6.920000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	1.030e-004	6.880000	7.360000	2.300000	7.120000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.424e-004	6.500000	6.720000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	2.303e-004	6.500000	6.920000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	2.910e-004	6.500000	7.120000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.027e-004	6.480000	6.960000	2.300000	6.720000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.027e-004	6.680000	7.160000	2.300000	6.920000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.027e-004	6.880000	7.360000	2.300000	7.120000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.418e-004	6.500000	6.720000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	2.293e-004	6.500000	6.920000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	2.898e-004	6.500000	7.120000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.2898	-111.2131
40.2892	-111.1854
40.2836	-111.1686
40.2573	-111.1420
40.2520	-111.1082
40.2380	-111.1039
40.2017	-111.1015
40.1678	-111.1149
40.1537	-111.1121
40.1433	-111.1199
40.1223	-111.1167
40.0904	-111.1429
40.0561	-111.1478
40.0075	-111.1393

------ End Nested Sources for Strawberry fault [2412] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Wasatch fault, Nephi section [2351h]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forWasatch fault, Nephi section [2351h] -------
Name: 2351h Wasatch fault, Nephi section (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 7.01

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	1.033e-003	6.570000	7.050000	2.300000	6.810000	0.120000	0.010000	10.000000

Normal	0.048002	Activity	1.033e-003	6.770000	7.250000	2.300000	7.010000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	1.033e-003	6.970000	7.450000	2.300000	7.210000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.931e-003	6.500000	6.810000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.703e-003	6.500000	7.010000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.238e-003	6.500000	7.210000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	1.033e-003	6.570000	7.050000	2.300000	6.810000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	1.033e-003	6.770000	7.250000	2.300000	7.010000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	1.033e-003	6.970000	7.450000	2.300000	7.210000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	1.931e-003	6.500000	6.810000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	2.703e-003	6.500000	7.010000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	3.238e-003	6.500000	7.210000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	1.033e-003	6.570000	7.050000	2.300000	6.810000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	1.033e-003	6.770000	7.250000	2.300000	7.010000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	1.033e-003	6.970000	7.450000	2.300000	7.210000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.931e-003	6.500000	6.810000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.703e-003	6.500000	7.010000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.238e-003	6.500000	7.210000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.0845	-111.7339
40.0673	-111.7354
40.0275	-111.7219
40.0121	-111.7324
40.0002	-111.7340
39.9922	-111.7519
39.9767	-111.7630
39.9443	-111.7578
39.9313	-111.7859
39.8824	-111.7917
39.8673	-111.8047
39.8285	-111.8072
39.8225	-111.8125
39.7507	-111.8285
39.7328	-111.8284
39.7066	-111.8165
39.7001	-111.8203

Name: 2351h Wasatch fault, Nephi section (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.54000108
Deterministic Magnitude: 7.01

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	1.033e-003	6.570000	7.050000	2.300000	6.810000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	1.033e-003	6.770000	7.250000	2.300000	7.010000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	1.033e-003	6.970000	7.450000	2.300000	7.210000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.931e-003	6.500000	6.810000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.703e-003	6.500000	7.010000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.238e-003	6.500000	7.210000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	1.033e-003	6.570000	7.050000	2.300000	6.810000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	1.033e-003	6.770000	7.250000	2.300000	7.010000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	1.033e-003	6.970000	7.450000	2.300000	7.210000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	1.931e-003	6.500000	6.810000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	2.703e-003	6.500000	7.010000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	3.238e-003	6.500000	7.210000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	1.033e-003	6.570000	7.050000	2.300000	6.810000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	1.033e-003	6.770000	7.250000	2.300000	7.010000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	1.033e-003	6.970000	7.450000	2.300000	7.210000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.931e-003	6.500000	6.810000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.703e-003	6.500000	7.010000	1.842068	0.000000	0.000000	0.000000	0.000000

Exponential	0.004000	Activity	3.238e-003	6.500000	7.210000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.0845	-111.7339
40.0673	-111.7354
40.0275	-111.7219
40.0121	-111.7324
40.0002	-111.7340
39.9922	-111.7519
39.9767	-111.7630
39.9443	-111.7578
39.9313	-111.7859
39.8824	-111.7917
39.8673	-111.8047
39.8285	-111.8072
39.8225	-111.8125
39.7507	-111.8285
39.7328	-111.8284
39.7066	-111.8165
39.7001	-111.8203

Name: 2351h Wasatch fault, Nephi section (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 7.01

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	1.033e-003	6.570000	7.050000	2.300000	6.810000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	1.033e-003	6.770000	7.250000	2.300000	7.010000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	1.033e-003	6.970000	7.450000	2.300000	7.210000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.931e-003	6.500000	6.810000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.703e-003	6.500000	7.010000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.238e-003	6.500000	7.210000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	1.033e-003	6.570000	7.050000	2.300000	6.810000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	1.033e-003	6.770000	7.250000	2.300000	7.010000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	1.033e-003	6.970000	7.450000	2.300000	7.210000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	1.931e-003	6.500000	6.810000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	2.703e-003	6.500000	7.010000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	3.238e-003	6.500000	7.210000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	1.033e-003	6.570000	7.050000	2.300000	6.810000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	1.033e-003	6.770000	7.250000	2.300000	7.010000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	1.033e-003	6.970000	7.450000	2.300000	7.210000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.931e-003	6.500000	6.810000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.703e-003	6.500000	7.010000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.238e-003	6.500000	7.210000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
40.0845	-111.7339
40.0673	-111.7354
40.0275	-111.7219
40.0121	-111.7324
40.0002	-111.7340
39.9922	-111.7519
39.9767	-111.7630
39.9443	-111.7578
39.9313	-111.7859
39.8824	-111.7917
39.8673	-111.8047
39.8285	-111.8072
39.8225	-111.8125
39.7507	-111.8285
39.7328	-111.8284
39.7066	-111.8165
39.7001	-111.8203

------ End Nested Sources for Wasatch fault, Nephi section [2351h] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: West Cache fault, Clarkston section [2521a]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forWest Cache fault, Clarkston section [2521a] -------
Name: 2521a West Cache fault, Clarkston section (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.66

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.699e-004	6.220000	6.700000	2.300000	6.460000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.699e-004	6.420000	6.900000	2.300000	6.660000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.699e-004	6.620000	7.100000	2.300000	6.860000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	5.247e-004	6.500000	6.660000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	6.036e-004	6.220000	6.700000	2.300000	6.460000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	6.036e-004	6.420000	6.900000	2.300000	6.660000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	6.036e-004	6.620000	7.100000	2.300000	6.860000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	8.562e-004	6.500000	6.660000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	5.779e-004	6.220000	6.700000	2.300000	6.460000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.779e-004	6.420000	6.900000	2.300000	6.660000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.779e-004	6.620000	7.100000	2.300000	6.860000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	8.198e-004	6.500000	6.660000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.8962	-112.0674

41.8981	-112.0709
41.9128	-112.0815
41.9210	-112.0901
41.9300	-112.0929
41.9391	-112.0991
41.9494	-112.1038
41.9530	-112.1027
41.9708	-112.1113
41.9823	-112.1102
41.9907	-112.1106
41.9951	-112.1075
41.9998	-112.0965
42.0086	-112.0943
42.0131	-112.0918
42.0304	-112.0914
42.0512	-112.0849
42.0755	-112.0816
42.0893	-112.0790

Name: 2521a West Cache fault, Clarkston section (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.66

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.699e-004	6.220000	6.700000	2.300000	6.460000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.699e-004	6.420000	6.900000	2.300000	6.660000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.699e-004	6.620000	7.100000	2.300000	6.860000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	5.247e-004	6.500000	6.660000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	6.036e-004	6.220000	6.700000	2.300000	6.460000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	6.036e-004	6.420000	6.900000	2.300000	6.660000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	6.036e-004	6.620000	7.100000	2.300000	6.860000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	8.562e-004	6.500000	6.660000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	5.779e-004	6.220000	6.700000	2.300000	6.460000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.779e-004	6.420000	6.900000	2.300000	6.660000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.779e-004	6.620000	7.100000	2.300000	6.860000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	8.198e-004	6.500000	6.660000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.8962	-112.0674
41.8981	-112.0709
41.9128	-112.0815
41.9210	-112.0901
41.9300	-112.0929
41.9391	-112.0991
41.9494	-112.1038
41.9530	-112.1027
41.9708	-112.1113
41.9823	-112.1102
41.9907	-112.1106
41.9951	-112.1075
41.9998	-112.0965
42.0086	-112.0943
42.0131	-112.0918
42.0304	-112.0914
42.0512	-112.0849
42.0755	-112.0816
42.0893	-112.0790

Name: 2521a West Cache fault, Clarkston section (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.66

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.699e-004	6.220000	6.700000	2.300000	6.460000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.699e-004	6.420000	6.900000	2.300000	6.660000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.699e-004	6.620000	7.100000	2.300000	6.860000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	5.247e-004	6.500000	6.660000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	6.036e-004	6.220000	6.700000	2.300000	6.460000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	6.036e-004	6.420000	6.900000	2.300000	6.660000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	6.036e-004	6.620000	7.100000	2.300000	6.860000	0.120000	0.010000	10.000000
Exponential	0.266670	Activity	8.562e-004	6.500000	6.660000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	5.779e-004	6.220000	6.700000	2.300000	6.460000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.779e-004	6.420000	6.900000	2.300000	6.660000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.779e-004	6.620000	7.100000	2.300000	6.860000	0.120000	0.010000	10.000000
Exponential	0.033330	Activity	8.198e-004	6.500000	6.660000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
41.8962	-112.0674
41.8981	-112.0709
41.9128	-112.0815
41.9210	-112.0901
41.9300	-112.0929
41.9391	-112.0991
41.9494	-112.1038
41.9530	-112.1027
41.9708	-112.1113
41.9823	-112.1102
41.9907	-112.1106
41.9951	-112.1075
41.9998	-112.0965
42.0086	-112.0943
42.0131	-112.0918
42.0304	-112.0914
42.0512	-112.0849
42.0755	-112.0816
42.0893	-112.0790

------ End Nested Sources for West Cache fault, Clarkston section [2521a] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Rock Creek fault [729]
Region: USGS 2014 Wyoming
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forRock Creek fault [729] -------
Name: 729 Rock Creek fault (dip 35)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.95

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.909e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000

Normal	0.040002	Activity	3.909e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.909e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	6.031e-004	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	9.209e-004	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.141e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	6.084e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	6.084e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	6.084e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	9.387e-004	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.433e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.775e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.398e-003	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.398e-003	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.398e-003	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	2.157e-003	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	3.294e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	4.080e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
42.1439	-110.8027
42.1238	-110.8028
42.0789	-110.8132
42.0147	-110.8080
41.9443	-110.8264
41.8695	-110.8274
41.8417	-110.8187
41.7993	-110.8212
41.7786	-110.8293

Name: 729 Rock Creek fault (dip 50)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 6.95

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.909e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.909e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.909e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	6.031e-004	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	9.209e-004	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.141e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	6.084e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	6.084e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	6.084e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	9.387e-004	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.433e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.775e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.398e-003	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.398e-003	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.398e-003	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	2.157e-003	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	3.294e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	4.080e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
42.1439	-110.8027
42.1238	-110.8028
42.0789	-110.8132
42.0147	-110.8080
41.9443	-110.8264
41.8695	-110.8274
41.8417	-110.8187
41.7993	-110.8212
41.7786	-110.8293

Name: 729 Rock Creek fault (dip 65)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 6.95

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	3.909e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	3.909e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	3.909e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	6.031e-004	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	9.209e-004	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.141e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	6.084e-004	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	6.084e-004	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	6.084e-004	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	9.387e-004	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.433e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.775e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	1.398e-003	6.510000	6.990000	2.300000	6.750000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.398e-003	6.710000	7.190000	2.300000	6.950000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.398e-003	6.910000	7.390000	2.300000	7.150000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	2.157e-003	6.500000	6.750000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	3.294e-003	6.500000	6.950000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	4.080e-003	6.500000	7.150000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
42.1439	-110.8027
42.1238	-110.8028
42.0789	-110.8132
42.0147	-110.8080
41.9443	-110.8264
41.8695	-110.8274
41.8417	-110.8187

```
    41.7993  -110.8212
    41.7786  -110.8293

 ------ End Nested Sources for Rock Creek fault [729] -------

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
      0.25      0.250000          Abrahamson-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Boore-et al (2014) NGA West 2 USGS 2014
      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

*****************************************

Name: Wasatch fault, Levan section [2351i]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
 ------ Start Nested Sources forWasatch fault, Levan section [2351i] -------
Name: 2351i Wasatch fault, Levan section (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 6.83

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        35         0     0.001        15

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag      Beta      Mean     Sigma    Delta1    Delta2
           Normal 0.0160008    Activity  4.864e-004  6.390000  6.870000  2.300000  6.630000  0.120000  0.010000 10.000000
           Normal  0.048002    Activity  4.864e-004  6.590000  7.070000  2.300000  6.830000  0.120000  0.010000 10.000000
           Normal  0.016001    Activity  4.864e-004  6.790000  7.270000  2.300000  7.030000  0.120000  0.010000 10.000000
      Exponential  0.004000    Activity  4.338e-004  6.500000  6.630000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.011999    Activity  9.279e-004  6.500000  6.830000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.004000    Activity  1.270e-003  6.500000  7.030000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.127999    Activity  3.527e-004  6.390000  6.870000  2.300000  6.630000  0.120000  0.010000 10.000000
           Normal  0.383997    Activity  3.527e-004  6.590000  7.070000  2.300000  6.830000  0.120000  0.010000 10.000000
           Normal  0.127999    Activity  3.527e-004  6.790000  7.270000  2.300000  7.030000  0.120000  0.010000 10.000000
      Exponential  0.032000    Activity  3.146e-004  6.500000  6.630000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.096001    Activity  6.730e-004  6.500000  6.830000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.032000    Activity  9.209e-004  6.500000  7.030000  1.842068  0.000000  0.000000  0.000000  0.000000
           Normal  0.016001    Activity  1.414e-003  6.390000  6.870000  2.300000  6.630000  0.120000  0.010000 10.000000
           Normal  0.048002    Activity  1.414e-003  6.590000  7.070000  2.300000  6.830000  0.120000  0.010000 10.000000
           Normal  0.016001    Activity  1.414e-003  6.790000  7.270000  2.300000  7.030000  0.120000  0.010000 10.000000
      Exponential  0.004000    Activity  1.261e-003  6.500000  6.630000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.011999    Activity  2.698e-003  6.500000  6.830000  1.842068  0.000000  0.000000  0.000000  0.000000
      Exponential  0.004000    Activity  3.692e-003  6.500000  7.030000  1.842068  0.000000  0.000000  0.000000  0.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw      Sigw        Aa        Ba      Sigw
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width  4.000000  0.000000  0.001000  4.000000  0.000000  0.001000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --
      Length and width -3.220000  0.690000  0.220000 -3.220000  0.690000  0.220000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    39.6434  -111.8276
    39.6241  -111.8206
    39.5740  -111.8216
    39.5504  -111.8321
    39.5271  -111.8621
    39.5057  -111.8600
    39.4888  -111.8717
    39.4793  -111.8842
    39.4571  -111.8851
    39.4335  -111.9133
    39.4211  -111.9148
    39.4182  -111.9206
    39.3864  -111.9192
```

39.3807 -111.9226

Name: 2351i Wasatch fault, Levan section (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.54000108
Deterministic Magnitude: 6.83

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	4.864e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	4.864e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	4.864e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	4.338e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	9.279e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	1.270e-003	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	3.527e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	3.527e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	3.527e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	3.146e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	6.730e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	9.209e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	1.414e-003	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	1.414e-003	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	1.414e-003	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.261e-003	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.698e-003	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.692e-003	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
39.6434	-111.8276
39.6241	-111.8206
39.5740	-111.8216
39.5504	-111.8321
39.5271	-111.8621
39.5057	-111.8600
39.4888	-111.8717
39.4793	-111.8842
39.4571	-111.8851
39.4335	-111.9133
39.4211	-111.9148
39.4182	-111.9206
39.3864	-111.9192
39.3807	-111.9226

Name: 2351i Wasatch fault, Levan section (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.18000036
Deterministic Magnitude: 6.83

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.0160008	Activity	4.864e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	4.864e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	4.864e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000

Exponential	0.004000	Activity	4.338e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	9.279e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	1.270e-003	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.127999	Activity	3.527e-004	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.383997	Activity	3.527e-004	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.127999	Activity	3.527e-004	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.032000	Activity	3.146e-004	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.096001	Activity	6.730e-004	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.032000	Activity	9.209e-004	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.016001	Activity	1.414e-003	6.390000	6.870000	2.300000	6.630000	0.120000	0.010000	10.000000
Normal	0.048002	Activity	1.414e-003	6.590000	7.070000	2.300000	6.830000	0.120000	0.010000	10.000000
Normal	0.016001	Activity	1.414e-003	6.790000	7.270000	2.300000	7.030000	0.120000	0.010000	10.000000
Exponential	0.004000	Activity	1.261e-003	6.500000	6.630000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.011999	Activity	2.698e-003	6.500000	6.830000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.004000	Activity	3.692e-003	6.500000	7.030000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
39.6434	-111.8276
39.6241	-111.8206
39.5740	-111.8216
39.5504	-111.8321
39.5271	-111.8621
39.5057	-111.8600
39.4888	-111.8717
39.4793	-111.8842
39.4571	-111.8851
39.4335	-111.9133
39.4211	-111.9148
39.4182	-111.9206
39.3864	-111.9192
39.3807	-111.9226

------ End Nested Sources for Wasatch fault, Levan section [2351i] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Joes Valley fault zone [2455]
Region: USGS 2014 Utah
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forJoes Valley fault zone [2455] -------
Name: 2455 Joes Valley fault zone (dip 35)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.02

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	9.307e-005	6.580000	7.060000	2.300000	6.820000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	9.307e-005	6.780000	7.260000	2.300000	7.020000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	9.307e-005	6.980000	7.460000	2.300000	7.220000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.790e-004	6.500000	6.820000	1.842068	0.000000	0.000000	0.000000	0.000000

Exponential	0.019998	Activity	2.478e-004	6.500000	7.020000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	2.953e-004	6.500000	7.220000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	9.307e-005	6.580000	7.060000	2.300000	6.820000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	9.307e-005	6.780000	7.260000	2.300000	7.020000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	9.307e-005	6.980000	7.460000	2.300000	7.220000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.790e-004	6.500000	6.820000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	2.478e-004	6.500000	7.020000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	2.953e-004	6.500000	7.220000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	9.307e-005	6.580000	7.060000	2.300000	6.820000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	9.307e-005	6.780000	7.260000	2.300000	7.020000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	9.307e-005	6.980000	7.460000	2.300000	7.220000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.790e-004	6.500000	6.820000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	2.478e-004	6.500000	7.020000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	2.953e-004	6.500000	7.220000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
39.5997	-111.2229
39.5312	-111.2190
39.5001	-111.2314
39.4681	-111.2288
39.4315	-111.2333
39.3599	-111.2579
39.3021	-111.2712
39.2583	-111.2703
39.1847	-111.2581

Name: 2455 Joes Valley fault zone (dip 50)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 7.02

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	9.307e-005	6.580000	7.060000	2.300000	6.820000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	9.307e-005	6.780000	7.260000	2.300000	7.020000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	9.307e-005	6.980000	7.460000	2.300000	7.220000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.790e-004	6.500000	6.820000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	2.478e-004	6.500000	7.020000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	2.953e-004	6.500000	7.220000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	9.307e-005	6.580000	7.060000	2.300000	6.820000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	9.307e-005	6.780000	7.260000	2.300000	7.020000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	9.307e-005	6.980000	7.460000	2.300000	7.220000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.790e-004	6.500000	6.820000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	2.478e-004	6.500000	7.020000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	2.953e-004	6.500000	7.220000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	9.307e-005	6.580000	7.060000	2.300000	6.820000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	9.307e-005	6.780000	7.260000	2.300000	7.020000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	9.307e-005	6.980000	7.460000	2.300000	7.220000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.790e-004	6.500000	6.820000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	2.478e-004	6.500000	7.020000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	2.953e-004	6.500000	7.220000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--

Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
39.5997	-111.2229
39.5312	-111.2190
39.5001	-111.2314
39.4681	-111.2288
39.4315	-111.2333
39.3599	-111.2579
39.3021	-111.2712
39.2583	-111.2703
39.1847	-111.2581

Name: 2455 Joes Valley fault zone (dip 65)
Region: USGS 2014 Utah
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.02

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	9.307e-005	6.580000	7.060000	2.300000	6.820000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	9.307e-005	6.780000	7.260000	2.300000	7.020000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	9.307e-005	6.980000	7.460000	2.300000	7.220000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.790e-004	6.500000	6.820000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	2.478e-004	6.500000	7.020000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	2.953e-004	6.500000	7.220000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	9.307e-005	6.580000	7.060000	2.300000	6.820000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	9.307e-005	6.780000	7.260000	2.300000	7.020000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	9.307e-005	6.980000	7.460000	2.300000	7.220000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.790e-004	6.500000	6.820000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	2.478e-004	6.500000	7.020000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	2.953e-004	6.500000	7.220000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	9.307e-005	6.580000	7.060000	2.300000	6.820000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	9.307e-005	6.780000	7.260000	2.300000	7.020000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	9.307e-005	6.980000	7.460000	2.300000	7.220000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.790e-004	6.500000	6.820000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	2.478e-004	6.500000	7.020000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	2.953e-004	6.500000	7.220000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
39.5997	-111.2229
39.5312	-111.2190
39.5001	-111.2314
39.4681	-111.2288
39.4315	-111.2333
39.3599	-111.2579
39.3021	-111.2712
39.2583	-111.2703
39.1847	-111.2581

------ End Nested Sources for Joes Valley fault zone [2455] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Grand Valley fault [726c]
Region: USGS 2014 Wyoming
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forGrand Valley fault [726c] -------
Name: 726c Grand Valley fault (dip 35)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.1

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.448e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.448e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.448e-004	7.060000	7.540000	2.300000	7.300000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	3.463e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.443e-004	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.121e-004	6.500000	7.300000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	6.304e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	6.304e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	6.304e-004	7.060000	7.540000	2.300000	7.300000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.507e-003	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.933e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	2.228e-003	6.500000	7.300000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	5.251e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.251e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.251e-004	7.060000	7.540000	2.300000	7.300000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.255e-003	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.611e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.856e-003	6.500000	7.300000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
43.0002	-110.9638
42.9661	-110.9366
42.8840	-110.8834
42.7976	-110.8851
42.7783	-110.8899
42.7103	-110.9256
42.6350	-110.9147
42.6190	-110.8967
42.5938	-110.8897
42.5851	-110.8799
42.5303	-110.8786

Name: 726c Grand Valley fault (dip 50)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal

Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 7.1

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.448e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.448e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.448e-004	7.060000	7.540000	2.300000	7.300000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	3.463e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.443e-004	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.121e-004	6.500000	7.300000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	6.304e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	6.304e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	6.304e-004	7.060000	7.540000	2.300000	7.300000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.507e-003	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.933e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	2.228e-003	6.500000	7.300000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	5.251e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.251e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.251e-004	7.060000	7.540000	2.300000	7.300000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.255e-003	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.611e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.856e-003	6.500000	7.300000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
43.0002	-110.9638
42.9661	-110.9366
42.8840	-110.8834
42.7976	-110.8851
42.7783	-110.8899
42.7103	-110.9256
42.6350	-110.9147
42.6190	-110.8967
42.5938	-110.8897
42.5851	-110.8799
42.5303	-110.8786

Name: 726c Grand Valley fault (dip 65)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.1

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	1.448e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	1.448e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	1.448e-004	7.060000	7.540000	2.300000	7.300000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	3.463e-004	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	4.443e-004	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	5.121e-004	6.500000	7.300000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	6.304e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	6.304e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	6.304e-004	7.060000	7.540000	2.300000	7.300000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.507e-003	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.933e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	2.228e-003	6.500000	7.300000	1.842068	0.000000	0.000000	0.000000	0.000000

Normal	0.013334	Activity	5.251e-004	6.660000	7.140000	2.300000	6.900000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.251e-004	6.860000	7.340000	2.300000	7.100000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.251e-004	7.060000	7.540000	2.300000	7.300000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.255e-003	6.500000	6.900000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.611e-003	6.500000	7.100000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.856e-003	6.500000	7.300000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
43.0002	-110.9638
42.9661	-110.9366
42.8840	-110.8834
42.7976	-110.8851
42.7783	-110.8899
42.7103	-110.9256
42.6350	-110.9147
42.6190	-110.8967
42.5938	-110.8897
42.5851	-110.8799
42.5303	-110.8786

------ End Nested Sources for Grand Valley fault [726c] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
0.25	0.250000	Chiou-Youngs (2014) NGA West 2 USGS 2014

****

Name: Greys River fault [728]
Region: USGS 2014 Wyoming
Category:Composite Seismic Source
Database: C:\Users\bill.turner\AppData\Local\Fugro\EZ-FRISK\Regions\USGS2014 Lower 48\Files\USGS 2014 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
------ Start Nested Sources forGreys River fault [728] -------
Name: 728 Greys River fault (dip 35)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.05

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	35	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	5.639e-004	6.610000	7.090000	2.300000	6.850000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.639e-004	6.810000	7.290000	2.300000	7.050000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.639e-004	7.010000	7.490000	2.300000	7.250000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.181e-003	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.583e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.861e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	5.246e-004	6.610000	7.090000	2.300000	6.850000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	5.246e-004	6.810000	7.290000	2.300000	7.050000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	5.246e-004	7.010000	7.490000	2.300000	7.250000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.099e-003	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.473e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.731e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	4.537e-004	6.610000	7.090000	2.300000	6.850000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.537e-004	6.810000	7.290000	2.300000	7.050000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.537e-004	7.010000	7.490000	2.300000	7.250000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	9.502e-004	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000

Exponential	0.019998	Activity	1.274e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.497e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
43.0007	-110.6907
42.9462	-110.6817
42.9268	-110.6833
42.8679	-110.6636
42.8434	-110.6690
42.7699	-110.6603
42.7131	-110.6626
42.6851	-110.6565
42.6589	-110.6581
42.6248	-110.6461
42.5554	-110.6464

Name: 728 Greys River fault (dip 50)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.60000000
Deterministic Magnitude: 7.05

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	50	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	5.639e-004	6.610000	7.090000	2.300000	6.850000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.639e-004	6.810000	7.290000	2.300000	7.050000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.639e-004	7.010000	7.490000	2.300000	7.250000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.181e-003	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.583e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.861e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	5.246e-004	6.610000	7.090000	2.300000	6.850000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	5.246e-004	6.810000	7.290000	2.300000	7.050000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	5.246e-004	7.010000	7.490000	2.300000	7.250000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.099e-003	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.473e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.731e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	4.537e-004	6.610000	7.090000	2.300000	6.850000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.537e-004	6.810000	7.290000	2.300000	7.050000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.537e-004	7.010000	7.490000	2.300000	7.250000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	9.502e-004	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.274e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.497e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
43.0007	-110.6907
42.9462	-110.6817
42.9268	-110.6833
42.8679	-110.6636
42.8434	-110.6690
42.7699	-110.6603
42.7131	-110.6626
42.6851	-110.6565
42.6589	-110.6581
42.6248	-110.6461
42.5554	-110.6464

Name: 728 Greys River fault (dip 65)
Region: USGS 2014 Wyoming
Category:Fault
Fault Mechanism: Normal
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.20000000
Deterministic Magnitude: 7.05

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	65	0	0.001	15

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Normal	0.013334	Activity	5.639e-004	6.610000	7.090000	2.300000	6.850000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	5.639e-004	6.810000	7.290000	2.300000	7.050000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	5.639e-004	7.010000	7.490000	2.300000	7.250000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	1.181e-003	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.583e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.861e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.106666	Activity	5.246e-004	6.610000	7.090000	2.300000	6.850000	0.120000	0.010000	10.000000
Normal	0.319998	Activity	5.246e-004	6.810000	7.290000	2.300000	7.050000	0.120000	0.010000	10.000000
Normal	0.106666	Activity	5.246e-004	7.010000	7.490000	2.300000	7.250000	0.120000	0.010000	10.000000
Exponential	0.053334	Activity	1.099e-003	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.160002	Activity	1.473e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.053334	Activity	1.731e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000
Normal	0.013334	Activity	4.537e-004	6.610000	7.090000	2.300000	6.850000	0.120000	0.010000	10.000000
Normal	0.040002	Activity	4.537e-004	6.810000	7.290000	2.300000	7.050000	0.120000	0.010000	10.000000
Normal	0.013334	Activity	4.537e-004	7.010000	7.490000	2.300000	7.250000	0.120000	0.010000	10.000000
Exponential	0.006666	Activity	9.502e-004	6.500000	6.850000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.019998	Activity	1.274e-003	6.500000	7.050000	1.842068	0.000000	0.000000	0.000000	0.000000
Exponential	0.006666	Activity	1.497e-003	6.500000	7.250000	1.842068	0.000000	0.000000	0.000000	0.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	4.000000	0.000000	0.001000	4.000000	0.000000	0.001000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--
Length and width	-3.220000	0.690000	0.220000	-3.220000	0.690000	0.220000	--	--	--

Trace Coordinates:

Latitude	Longitude
43.0007	-110.6907
42.9462	-110.6817
42.9268	-110.6833
42.8679	-110.6636
42.8434	-110.6690
42.7699	-110.6603
42.7131	-110.6626
42.6851	-110.6565
42.6589	-110.6581
42.6248	-110.6461
42.5554	-110.6464

------ End Nested Sources for Greys River fault [728] -------

Attenuation Equations for Source:

Raw Weight	Normalized Weight	Name
0.25	0.250000	Abrahamson-et al (2014) NGA West 2 USGS 2014
0.25	0.250000	Boore-et al (2014) NGA West 2 USGS 2014

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      0.25      0.250000          Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
      0.25      0.250000          Chiou-Youngs (2014) NGA West 2 USGS 2014

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MAGNITUDE CONVERSIONS

This analysis does not require any magnitude conversions.
Note:  Your analysis may indirectly use magnitude conversions that are not listed here.

Echo File Creation Time: 18:07:47 Tuesday, July 02, 2024
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Probabilistic Hazard Results for EZ-FRISK 8.07 Build 044

SPECTRAL PERIOD: PGA
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Frankel (1996) USGS 2008 Truncated Mw
Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
Column 5: Silva et al (2002) USGS 2008 Mw
Column 6: Campbell (2003) USGS 2008 Mw
Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
Column 10: Atkinson (2008p) USGS 2014 Table Soil
Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 12: Boore-et al (2014) NGA West 2 USGS 2014
Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001
5.0e-004	1.795e-001	9.430e-003	9.430e-003	9.403e-003	9.430e-003	9.429e-003	9.418e-003	9.423e-003	9.409e-003	1.702e-001	1.717e-001	1.686e-001	1.697e-001
1.0e-003	1.711e-001	9.423e-003	9.423e-003	9.228e-003	9.430e-003	9.394e-003	9.267e-003	9.328e-003	9.219e-003	1.621e-001	1.679e-001	1.567e-001	1.606e-001
5.0e-003	1.068e-001	8.433e-003	8.333e-003	6.252e-003	9.171e-003	7.058e-003	5.192e-003	6.086e-003	5.923e-003	9.941e-002	1.172e-001	8.652e-002	9.696e-002
7.0e-003	8.888e-002	7.622e-003	7.429e-003	5.120e-003	8.737e-003	5.757e-003	3.733e-003	4.666e-003	4.818e-003	8.273e-002	9.923e-002	7.047e-002	8.038e-002
0.010	7.068e-002	6.454e-003	6.141e-003	3.919e-003	7.847e-003	4.271e-003	2.378e-003	3.202e-003	3.707e-003	6.619e-002	7.992e-002	5.514e-002	6.388e-002
0.020	4.094e-002	3.787e-003	3.324e-003	1.988e-003	4.894e-003	1.863e-003	7.378e-004	1.159e-003	1.974e-003	3.957e-002	4.678e-002	3.149e-002	3.716e-002
0.050	1.614e-002	1.204e-003	8.932e-004	6.096e-004	1.321e-003	3.954e-004	9.497e-005	1.820e-004	6.486e-004	1.682e-002	1.836e-002	1.244e-002	1.471e-002
0.070	1.087e-002	7.066e-004	4.888e-004	3.689e-004	6.744e-004	2.015e-004	4.260e-005	8.486e-005	3.867e-004	1.168e-002	1.227e-002	8.417e-003	9.934e-003
0.100	6.989e-003	3.806e-004	2.459e-004	2.093e-004	3.043e-004	9.538e-005	1.949e-005	3.846e-005	2.067e-004	7.727e-003	7.800e-003	5.438e-003	6.405e-003
0.200	2.772e-003	1.010e-004	6.054e-005	6.306e-005	6.026e-005	2.432e-005	5.820e-006	9.751e-006	4.728e-005	3.233e-003	2.992e-003	2.152e-003	2.572e-003
0.300	1.492e-003	4.359e-005	2.589e-005	2.920e-005	2.492e-005	1.262e-005	3.082e-006	4.747e-006	1.703e-005	1.822e-003	1.549e-003	1.106e-003	1.429e-003
0.400	8.867e-004	2.326e-005	1.379e-005	1.628e-005	1.364e-005	8.187e-006	1.896e-006	2.812e-006	7.767e-006	1.129e-003	8.873e-004	6.027e-004	8.936e-004
0.500	5.476e-004	1.397e-005	8.260e-006	1.008e-005	8.488e-006	5.810e-006	1.257e-006	1.822e-006	4.115e-006	7.226e-004	5.349e-004	3.289e-004	5.828e-004
0.600	3.443e-004	9.058e-006	5.315e-006	6.680e-006	5.684e-006	4.330e-006	8.736e-007	1.244e-006	2.421e-006	4.684e-004	3.333e-004	1.778e-004	3.837e-004
0.700	2.191e-004	6.191e-006	3.594e-006	4.644e-006	3.990e-006	3.329e-006	6.280e-007	8.811e-007	1.536e-006	3.059e-004	2.127e-004	9.537e-005	2.523e-004
0.800	1.408e-004	4.403e-006	2.521e-006	3.345e-006	2.897e-006	2.615e-006	4.631e-007	6.410e-007	1.031e-006	2.008e-004	1.382e-004	5.108e-005	1.658e-004
1.000	5.967e-005	2.423e-006	1.339e-006	1.873e-006	1.638e-006	1.684e-006	2.661e-007	3.591e-007	5.227e-007	8.761e-005	6.080e-005	1.449e-005	7.167e-005
1.200	2.611e-005	1.441e-006	7.641e-007	1.125e-006	9.852e-007	1.123e-006	1.610e-007	2.121e-007	2.939e-007	3.891e-005	2.804e-005	3.869e-006	3.113e-005
1.500	7.722e-006	7.204e-007	3.573e-007	5.666e-007	4.912e-007	6.299e-007	8.047e-008	1.026e-007	1.387e-007	1.162e-005	9.080e-006	2.641e-008	8.895e-006
2.000	8.154e-007	2.492e-007	1.098e-007	1.963e-007	1.616e-007	2.397e-007	2.698e-008	3.286e-008	4.495e-008	1.163e-006	1.080e-006	2.537e-306	5.829e-007
3.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
4.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
5.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
7.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 0.02
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Frankel (1996) USGS 2008 Truncated Mw
Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
Column 5: Silva et al (2002) USGS 2008 Mw
Column 6: Campbell (2003) USGS 2008 Mw
Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
Column 10: Atkinson (2008p) USGS 2014 Table Soil
Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 12: Boore-et al (2014) NGA West 2 USGS 2014
Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001
5.0e-004	1.794e-001	9.430e-003	9.430e-003	9.419e-003	9.430e-003	9.430e-003	9.429e-003	9.423e-003	9.423e-003	1.702e-001	1.716e-001	1.684e-001	1.696e-001
1.0e-003	1.710e-001	9.427e-003	9.428e-003	9.329e-003	9.430e-003	9.418e-003	9.407e-003	9.330e-003	9.334e-003	1.622e-001	1.676e-001	1.563e-001	1.605e-001
5.0e-003	1.075e-001	8.783e-003	8.790e-003	7.068e-003	9.311e-003	7.967e-003	7.446e-003	6.124e-003	6.882e-003	1.000e-001	1.162e-001	8.620e-002	9.666e-002
7.0e-003	8.973e-002	8.154e-003	8.137e-003	6.017e-003	9.067e-003	6.916e-003	6.194e-003	4.708e-003	5.843e-003	8.334e-002	9.821e-002	7.024e-002	8.011e-002
0.010	7.161e-002	7.156e-003	7.084e-003	4.806e-003	8.489e-003	5.534e-003	4.660e-003	3.242e-003	4.700e-003	6.678e-002	7.892e-002	5.500e-002	6.364e-002
0.020	4.170e-002	4.549e-003	4.334e-003	2.638e-003	6.105e-003	2.819e-003	1.989e-003	1.183e-003	2.720e-003	4.006e-002	4.602e-002	3.148e-002	3.702e-002
0.050	1.648e-002	1.589e-003	1.366e-003	8.809e-004	2.209e-003	7.139e-004	3.522e-004	1.889e-004	1.019e-003	1.710e-002	1.801e-002	1.252e-002	1.467e-002
0.070	1.110e-002	9.564e-004	7.836e-004	5.465e-004	1.281e-003	3.823e-004	1.624e-004	8.895e-005	6.488e-004	1.189e-002	1.204e-002	8.490e-003	9.922e-003
0.100	7.129e-003	5.252e-004	4.088e-004	3.175e-004	6.618e-004	1.868e-004	7.042e-005	4.092e-005	3.760e-004	7.870e-003	7.660e-003	5.503e-003	6.409e-003
0.200	2.825e-003	1.417e-004	1.035e-004	9.989e-005	1.617e-004	4.477e-005	1.757e-005	1.079e-005	1.036e-004	3.285e-003	2.950e-003	2.205e-003	2.585e-003
0.300	1.525e-003	6.118e-005	4.475e-005	4.764e-005	7.099e-005	2.129e-005	9.630e-006	5.397e-006	4.197e-005	1.842e-003	1.533e-003	1.161e-003	1.440e-003
0.400	9.108e-004	3.264e-005	2.422e-005	2.724e-005	4.032e-005	1.331e-005	6.544e-006	3.267e-006	2.075e-005	1.133e-003	8.817e-004	6.548e-004	9.031e-004
0.500	5.652e-004	1.963e-005	1.478e-005	1.726e-005	2.623e-005	9.395e-006	4.826e-006	2.156e-006	1.164e-005	7.194e-004	5.341e-004	3.714e-004	5.908e-004
0.600	3.568e-004	1.275e-005	9.716e-006	1.170e-005	1.854e-005	7.058e-006	3.715e-006	1.498e-006	7.137e-006	4.622e-004	3.346e-004	2.088e-004	3.905e-004
0.700	2.277e-004	8.750e-006	6.721e-006	8.311e-006	1.386e-005	5.504e-006	2.940e-006	1.078e-006	4.679e-006	2.990e-004	2.149e-004	1.163e-004	2.580e-004
0.800	1.468e-004	6.252e-006	4.824e-006	6.117e-006	1.078e-005	4.403e-006	2.375e-006	7.970e-007	3.230e-006	1.943e-004	1.405e-004	6.460e-005	1.704e-004
1.000	6.267e-005	3.487e-006	2.690e-006	3.578e-006	7.066e-006	2.968e-006	1.619e-006	4.615e-007	1.724e-006	8.307e-005	6.264e-005	1.975e-005	7.443e-005
1.200	2.781e-005	2.118e-006	1.617e-006	2.254e-006	4.978e-006	2.095e-006	1.151e-006	2.826e-007	1.024e-006	3.611e-005	2.932e-005	5.881e-006	3.269e-005
1.500	8.598e-006	1.117e-006	8.279e-007	1.237e-006	3.195e-006	1.312e-006	7.282e-007	1.457e-007	5.330e-007	1.038e-005	9.741e-006	4.048e-007	9.533e-006
2.000	1.252e-006	4.618e-007	3.186e-007	5.341e-007	1.722e-006	6.545e-007	3.728e-007	5.559e-008	2.199e-007	8.708e-007	1.296e-006	2.537e-306	7.210e-007
3.000	1.619e-007	1.137e-007	6.473e-008	1.360e-007	6.017e-007	1.896e-007	1.183e-007	1.071e-008	5.421e-008	2.537e-306	2.537e-306	2.537e-306	2.537e-306
4.000	5.446e-008	3.486e-008	1.637e-008	4.071e-008	2.181e-007	5.832e-008	4.093e-008	2.190e-009	1.609e-008	2.537e-306	2.537e-306	2.537e-306	2.537e-306
5.000	1.581e-008	9.955e-009	3.919e-009	1.133e-008	6.594e-008	1.553e-008	1.219e-008	2.721e-010	4.282e-009	2.537e-306	2.537e-306	2.537e-306	2.537e-306
7.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 0.03

- **Column 1: Acceleration (g)**
- **Column 2: Mean**
- **Column 3: Frankel (1996) USGS 2008 Truncated Mw**
- **Column 4: Toro (1999) Midcontinent - USGS 2008 Mw**
- **Column 5: Silva et al (2002) USGS 2008 Mw**
- **Column 6: Campbell (2003) USGS 2008 Mw**
- **Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw**
- **Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil**
- **Column 9: Pezeshk et al (2011) USGS 2014 Table Soil**
- **Column 10: Atkinson (2008p) USGS 2014 Table Soil**
- **Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014**
- **Column 12: Boore-et al (2014) NGA West 2 USGS 2014**
- **Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014**
- **Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014**

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001
5.0e-004	1.791e-001	9.430e-003	9.430e-003	9.424e-003	9.430e-003	9.430e-003	9.429e-003	9.414e-003	9.415e-003	1.703e-001	1.715e-001	1.678e-001	1.692e-001
1.0e-003	1.705e-001	9.429e-003	9.429e-003	9.365e-003	9.430e-003	9.424e-003	9.399e-003	9.255e-003	9.271e-003	1.626e-001	1.673e-001	1.551e-001	1.594e-001
5.0e-003	1.074e-001	8.941e-003	8.980e-003	7.494e-003	9.386e-003	8.369e-003	7.301e-003	5.457e-003	6.436e-003	1.017e-001	1.159e-001	8.536e-002	9.583e-002
7.0e-003	8.990e-002	8.414e-003	8.462e-003	6.519e-003	9.272e-003	7.489e-003	6.039e-003	4.048e-003	5.390e-003	8.508e-002	9.813e-002	6.970e-002	7.962e-002
0.010	7.206e-002	7.527e-003	7.564e-003	5.336e-003	8.947e-003	6.236e-003	4.525e-003	2.688e-003	4.286e-003	6.845e-002	7.906e-002	5.474e-002	6.348e-002
0.020	4.251e-002	5.011e-003	4.951e-003	3.071e-003	7.193e-003	3.472e-003	1.932e-003	9.283e-004	2.442e-003	4.136e-002	4.643e-002	3.158e-002	3.728e-002
0.050	1.714e-002	1.857e-003	1.717e-003	1.082e-003	3.210e-003	9.845e-004	3.512e-004	1.506e-004	8.987e-004	1.780e-002	1.844e-002	1.274e-002	1.505e-002

0.070	1.160e-002	1.137e-003	1.015e-003	6.822e-004	2.002e-003	5.457e-004	1.663e-004	7.551e-005	5.684e-004	1.238e-002	1.240e-002	8.690e-003	1.025e-002
0.100	7.473e-003	6.332e-004	5.441e-004	4.022e-004	1.101e-003	2.745e-004	7.517e-005	3.840e-005	3.280e-004	8.184e-003	7.937e-003	5.662e-003	6.659e-003
0.200	2.956e-003	1.733e-004	1.415e-004	1.299e-004	2.768e-004	6.590e-005	2.083e-005	1.284e-005	9.183e-005	3.358e-003	3.090e-003	2.291e-003	2.700e-003
0.300	1.586e-003	7.503e-005	6.154e-005	6.295e-005	1.155e-004	3.000e-005	1.199e-005	7.262e-006	3.862e-005	1.832e-003	1.623e-003	1.223e-003	1.497e-003
0.400	9.413e-004	4.006e-005	3.352e-005	3.647e-005	6.212e-005	1.815e-005	8.415e-006	4.779e-006	1.999e-005	1.087e-003	9.460e-004	7.052e-004	9.315e-004
0.500	5.802e-004	2.411e-005	2.063e-005	2.338e-005	3.871e-005	1.262e-005	6.386e-006	3.376e-006	1.180e-005	6.616e-004	5.819e-004	4.110e-004	6.053e-004
0.600	3.641e-004	1.567e-005	1.368e-005	1.601e-005	2.648e-005	9.433e-006	5.052e-006	2.491e-006	7.633e-006	4.062e-004	3.707e-004	2.380e-004	3.988e-004
0.700	2.311e-004	1.076e-005	9.558e-006	1.149e-005	1.931e-005	7.367e-006	4.106e-006	1.896e-006	5.289e-006	2.509e-004	2.424e-004	1.366e-004	2.634e-004
0.800	1.484e-004	7.693e-006	6.930e-006	8.535e-006	1.474e-005	5.919e-006	3.403e-006	1.476e-006	3.862e-006	1.556e-004	1.618e-004	7.820e-005	1.741e-004
1.000	6.320e-005	4.298e-006	3.944e-006	5.079e-006	9.437e-006	4.040e-006	2.437e-006	9.417e-007	2.309e-006	6.039e-005	7.519e-005	2.547e-005	7.667e-005
1.200	2.825e-005	2.615e-006	2.418e-006	3.248e-006	6.557e-006	2.897e-006	1.815e-006	6.308e-007	1.533e-006	2.373e-005	3.673e-005	8.209e-006	3.405e-005
1.500	9.091e-006	1.383e-006	1.275e-006	1.821e-006	4.166e-006	1.865e-006	1.224e-006	3.682e-007	9.341e-007	5.627e-006	1.322e-005	1.016e-006	1.017e-005
2.000	1.620e-006	5.757e-007	5.141e-007	8.114e-007	2.239e-006	9.794e-007	6.890e-007	1.679e-007	4.858e-007	1.556e-008	2.354e-006	2.537e-306	8.845e-007
3.000	2.652e-007	1.435e-007	1.142e-007	2.191e-007	7.936e-007	3.155e-007	2.545e-007	4.476e-008	1.698e-007	2.537e-306	2.537e-306	2.537e-306	2.537e-306
4.000	9.465e-008	4.408e-008	3.031e-008	6.844e-008	2.935e-007	1.066e-007	9.851e-008	1.364e-008	6.428e-008	2.537e-306	2.537e-306	2.537e-306	2.537e-306
5.000	2.873e-008	1.261e-008	7.645e-009	1.903e-008	8.988e-008	3.038e-008	3.184e-008	3.797e-009	2.048e-008	2.537e-306	2.537e-306	2.537e-306	2.537e-306
7.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 0.05

- **Column 1: Acceleration (g)**
- **Column 2: Mean**
- **Column 3: Frankel (1996) USGS 2008 Truncated Mw**
- **Column 4: Toro (1999) Midcontinent - USGS 2008 Mw**
- **Column 5: Silva et al (2002) USGS 2008 Mw**
- **Column 6: Campbell (2003) USGS 2008 Mw**
- **Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw**
- **Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil**
- **Column 9: Pezeshk et al (2011) USGS 2014 Table Soil**
- **Column 10: Atkinson (2008p) USGS 2014 Table Soil**
- **Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014**
- **Column 12: Boore-et al (2014) NGA West 2 USGS 2014**
- **Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014**
- **Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014**

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001
5.0e-004	1.790e-001	9.430e-003	9.430e-003	9.427e-003	9.430e-003	9.430e-003	9.427e-003	9.371e-003	9.374e-003	1.706e-001	1.712e-001	1.673e-001	1.691e-001
1.0e-003	1.704e-001	9.429e-003	9.430e-003	9.394e-003	9.430e-003	9.428e-003	9.367e-003	8.977e-003	9.025e-003	1.641e-001	1.665e-001	1.544e-001	1.595e-001
5.0e-003	1.097e-001	9.095e-003	9.153e-003	7.966e-003	9.410e-003	8.751e-003	6.567e-003	3.995e-003	5.252e-003	1.074e-001	1.164e-001	8.727e-002	9.882e-002
7.0e-003	9.281e-002	8.687e-003	8.783e-003	7.107e-003	9.351e-003	8.083e-003	5.175e-003	2.714e-003	4.210e-003	9.092e-002	9.947e-002	7.206e-002	8.311e-002
0.010	7.541e-002	7.946e-003	8.078e-003	5.995e-003	9.164e-003	7.033e-003	3.656e-003	1.643e-003	3.203e-003	7.408e-002	8.125e-002	5.735e-002	6.725e-002
0.020	4.607e-002	5.598e-003	5.723e-003	3.666e-003	7.940e-003	4.353e-003	1.379e-003	4.856e-004	1.673e-003	4.592e-002	4.950e-002	3.414e-002	4.090e-002
0.050	1.969e-002	2.242e-003	2.240e-003	1.387e-003	4.246e-003	1.431e-003	2.165e-004	7.520e-005	5.271e-004	2.046e-002	2.095e-002	1.449e-002	1.743e-002
0.070	1.359e-002	1.405e-003	1.379e-003	8.936e-004	2.846e-003	8.326e-004	9.969e-005	4.015e-005	3.094e-004	1.439e-002	1.444e-002	1.006e-002	1.207e-002
0.100	8.891e-003	7.989e-004	7.676e-004	5.376e-004	1.673e-003	4.378e-004	4.514e-005	2.232e-005	1.637e-004	9.580e-003	9.451e-003	6.654e-003	7.948e-003
0.200	3.572e-003	2.239e-004	2.086e-004	1.796e-004	4.421e-004	1.089e-004	1.306e-005	8.381e-006	3.836e-005	3.914e-003	3.827e-003	2.767e-003	3.258e-003
0.300	1.932e-003	9.750e-005	9.175e-005	8.877e-005	1.759e-004	4.792e-005	7.357e-006	4.707e-006	1.470e-005	2.102e-003	2.087e-003	1.514e-003	1.800e-003
0.400	1.159e-003	5.219e-005	5.036e-005	5.224e-005	8.800e-005	2.785e-005	4.931e-006	3.001e-006	7.258e-006	1.226e-003	1.273e-003	9.037e-004	1.111e-003
0.500	7.265e-004	3.145e-005	3.123e-005	3.396e-005	5.106e-005	1.882e-005	3.562e-006	2.049e-006	4.209e-006	7.353e-004	8.234e-004	5.537e-004	7.189e-004
0.600	4.659e-004	2.047e-005	2.092e-005	2.354e-005	3.278e-005	1.386e-005	2.690e-006	1.462e-006	2.727e-006	4.451e-004	5.538e-004	3.409e-004	4.737e-004
0.700	3.034e-004	1.407e-005	1.476e-005	1.709e-005	2.260e-005	1.075e-005	2.095e-006	1.078e-006	1.912e-006	2.709e-004	3.830e-004	2.098e-004	3.141e-004
0.800	2.002e-004	1.007e-005	1.081e-005	1.283e-005	1.642e-005	8.634e-006	1.668e-006	8.141e-007	1.419e-006	1.659e-004	2.708e-004	1.289e-004	2.086e-004

1.000	9.072e-005	5.640e-006	6.290e-006	7.785e-006	9.656e-006	5.939e-006	1.110e-006	4.900e-007	8.758e-007	6.276e-005	1.424e-004	4.882e-005	9.256e-005
1.200	4.338e-005	3.438e-006	3.941e-006	5.069e-006	6.258e-006	4.313e-006	7.741e-007	3.107e-007	5.932e-007	2.399e-005	7.869e-005	1.855e-005	4.151e-005
1.500	1.577e-005	1.823e-006	2.144e-006	2.911e-006	3.653e-006	2.842e-006	4.776e-007	1.683e-007	3.635e-007	5.447e-006	3.448e-005	4.193e-006	1.262e-005
2.000	3.535e-006	7.639e-007	9.091e-007	1.344e-006	1.763e-006	1.564e-006	2.367e-007	6.922e-008	1.831e-007	4.565e-009	9.783e-006	2.192e-013	1.306e-006
3.000	3.499e-007	1.931e-007	2.226e-007	3.864e-007	5.457e-007	5.583e-007	7.150e-008	1.532e-008	5.719e-008	2.537e-306	4.712e-007	2.537e-306	2.537e-306
4.000	7.904e-008	5.954e-008	6.366e-008	1.280e-007	1.873e-007	2.077e-007	2.391e-008	3.922e-009	1.942e-008	2.537e-306	2.537e-306	2.537e-306	2.537e-306
5.000	2.310e-008	1.698e-008	1.648e-008	3.696e-008	5.469e-008	6.419e-008	6.842e-009	6.607e-010	5.660e-009	2.537e-306	2.537e-306	2.537e-306	2.537e-306
7.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 0.075

Column 1: Acceleration (g)
Column 2: Mean
Column 3: Frankel (1996) USGS 2008 Truncated Mw
Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
Column 5: Silva et al (2002) USGS 2008 Mw
Column 6: Campbell (2003) USGS 2008 Mw
Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
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Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 12: Boore-et al (2014) NGA West 2 USGS 2014
Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001
5.0e-004	1.798e-001	9.430e-003	9.429e-003	9.430e-003	9.430e-003	9.429e-003	9.427e-003	9.419e-003	1.711e-001	1.716e-001	1.689e-001	1.700e-001	
1.0e-003	1.733e-001	9.430e-003	9.430e-003	9.408e-003	9.430e-003	9.428e-003	9.410e-003	9.383e-003	9.298e-003	1.659e-001	1.680e-001	1.591e-001	1.623e-001
5.0e-003	1.193e-001	9.188e-003	9.247e-003	8.284e-003	9.415e-003	8.777e-003	7.538e-003	7.014e-003	6.454e-003	1.148e-001	1.247e-001	9.797e-002	1.071e-001
7.0e-003	1.028e-001	8.863e-003	8.974e-003	7.529e-003	9.370e-003	8.117e-003	6.311e-003	5.708e-003	5.364e-003	9.879e-002	1.088e-001	8.243e-002	9.168e-002
0.010	8.517e-002	8.235e-003	8.412e-003	6.498e-003	9.222e-003	7.064e-003	4.791e-003	4.201e-003	4.218e-003	8.193e-002	9.096e-002	6.689e-002	7.570e-002
0.020	5.416e-002	6.058e-003	6.312e-003	4.170e-003	8.164e-003	4.345e-003	2.100e-003	1.747e-003	2.338e-003	5.270e-002	5.815e-002	4.138e-002	4.819e-002
0.050	2.458e-002	2.586e-003	2.719e-003	1.673e-003	4.586e-003	1.393e-003	3.934e-004	3.204e-004	8.093e-004	2.490e-002	2.630e-002	1.857e-002	2.214e-002
0.070	1.734e-002	1.653e-003	1.731e-003	1.098e-003	3.122e-003	8.015e-004	1.852e-004	1.535e-004	4.930e-004	1.790e-002	1.855e-002	1.314e-002	1.573e-002
0.100	1.159e-002	9.574e-004	9.942e-004	6.721e-004	1.853e-003	4.176e-004	8.070e-005	6.974e-005	2.701e-004	1.219e-002	1.240e-002	8.847e-003	1.062e-002
0.200	4.822e-003	2.747e-004	2.823e-004	2.310e-004	4.829e-004	1.042e-004	1.836e-005	1.738e-005	6.603e-005	5.150e-003	5.202e-003	3.790e-003	4.523e-003
0.300	2.677e-003	1.204e-004	1.257e-004	1.160e-004	1.856e-004	4.671e-005	9.171e-006	8.694e-006	2.519e-005	2.829e-003	2.931e-003	2.130e-003	2.553e-003
0.400	1.654e-003	6.465e-005	6.940e-005	6.905e-005	8.968e-005	2.755e-005	5.878e-006	5.442e-006	1.214e-005	1.703e-003	1.858e-003	1.306e-003	1.605e-003
0.500	1.073e-003	3.904e-005	4.329e-005	4.534e-005	5.065e-005	1.879e-005	4.174e-006	3.754e-006	6.806e-006	1.062e-003	1.254e-003	8.292e-004	1.060e-003
0.600	7.160e-004	2.545e-005	2.917e-005	3.173e-005	3.188e-005	1.390e-005	3.130e-006	2.731e-006	4.255e-006	6.723e-004	8.815e-004	5.349e-004	7.165e-004
0.700	4.863e-004	1.752e-005	2.071e-005	2.322e-005	2.164e-005	1.081e-005	2.430e-006	2.058e-006	2.883e-006	4.288e-004	6.374e-004	3.482e-004	4.886e-004
0.800	3.350e-004	1.256e-005	1.528e-005	1.757e-005	1.550e-005	8.675e-006	1.934e-006	1.591e-006	2.078e-006	2.749e-004	4.712e-004	2.280e-004	3.344e-004
1.000	1.652e-004	7.045e-006	9.018e-006	1.082e-005	8.875e-006	5.942e-006	1.292e-006	1.003e-006	1.227e-006	1.148e-004	2.705e-004	9.937e-005	1.569e-004
1.200	8.548e-005	4.301e-006	5.733e-006	7.134e-006	5.597e-006	4.282e-006	9.056e-007	6.666e-007	8.106e-007	4.846e-005	1.633e-004	4.390e-005	7.381e-005
1.500	3.500e-005	2.286e-006	3.187e-006	4.168e-006	3.125e-006	2.777e-006	5.653e-007	3.855e-007	4.903e-007	1.344e-005	8.201e-005	1.325e-005	2.405e-005
2.000	9.679e-006	9.608e-007	1.399e-006	1.974e-006	1.396e-006	1.478e-006	2.862e-007	1.737e-007	2.488e-007	1.211e-006	2.911e-005	1.523e-006	3.464e-006
3.000	1.419e-006	2.454e-007	3.651e-007	5.916e-007	3.732e-007	4.920e-007	9.007e-008	4.556e-008	8.129e-008	2.537e-306	4.691e-006	2.537e-306	2.537e-306
4.000	1.862e-007	7.607e-008	1.107e-007	2.038e-007	1.141e-007	1.720e-007	3.121e-008	1.380e-008	2.882e-008	2.537e-306	4.219e-007	2.537e-306	2.537e-306
5.000	2.300e-008	2.160e-008	2.973e-008	6.082e-008	3.056e-008	5.071e-008	9.270e-009	3.809e-009	8.690e-009	2.537e-306	2.537e-306	2.537e-306	2.537e-306
7.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 0.1
  Column 1: Acceleration (g)
  Column 2: Mean
  Column 3: Frankel (1996) USGS 2008 Truncated Mw
  Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
  Column 5: Silva et al (2002) USGS 2008 Mw
  Column 6: Campbell (2003) USGS 2008 Mw
  Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
  Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
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  Column 12: Boore-et al (2014) NGA West 2 USGS 2014
  Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001
5.0e-004	1.807e-001	9.430e-003	9.430e-003	9.429e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.427e-003	1.715e-001	1.720e-001	1.708e-001	1.709e-001
1.0e-003	1.763e-001	9.430e-003	9.430e-003	9.415e-003	9.430e-003	9.428e-003	9.422e-003	9.425e-003	9.380e-003	1.677e-001	1.699e-001	1.648e-001	1.652e-001
5.0e-003	1.298e-001	9.241e-003	9.296e-003	8.479e-003	9.417e-003	8.881e-003	8.102e-003	8.489e-003	7.284e-003	1.225e-001	1.348e-001	1.122e-001	1.151e-001
7.0e-003	1.137e-001	8.968e-003	9.080e-003	7.801e-003	9.376e-003	8.300e-003	7.052e-003	7.654e-003	6.242e-003	1.070e-001	1.200e-001	9.632e-002	9.976e-002
0.010	9.600e-002	8.416e-003	8.611e-003	6.837e-003	9.238e-003	7.344e-003	5.619e-003	6.410e-003	5.052e-003	9.021e-002	1.025e-001	7.973e-002	8.344e-002
0.020	6.313e-002	6.376e-003	6.707e-003	4.539e-003	8.227e-003	4.739e-003	2.736e-003	3.518e-003	2.933e-003	5.998e-002	6.815e-002	5.106e-002	5.456e-002
0.050	2.994e-002	2.850e-003	3.088e-003	1.900e-003	4.656e-003	1.656e-003	5.874e-004	8.904e-004	1.086e-003	2.989e-002	3.208e-002	2.398e-002	2.625e-002
0.070	2.145e-002	1.850e-003	2.014e-003	1.265e-003	3.164e-003	9.850e-004	2.868e-004	4.587e-004	6.813e-004	2.198e-002	2.285e-002	1.723e-002	1.901e-002
0.100	1.456e-002	1.086e-003	1.185e-003	7.843e-004	1.865e-003	5.283e-004	1.262e-004	2.101e-004	3.853e-004	1.533e-002	1.539e-002	1.176e-002	1.308e-002
0.200	6.233e-003	3.176e-004	3.483e-004	2.752e-004	4.721e-004	1.314e-004	2.556e-005	4.175e-005	9.877e-005	6.814e-003	6.480e-003	5.138e-003	5.779e-003
0.300	3.542e-003	1.401e-004	1.568e-004	1.397e-004	1.767e-004	5.488e-005	1.144e-005	1.711e-005	3.800e-005	3.887e-003	3.667e-003	2.963e-003	3.348e-003
0.400	2.247e-003	7.541e-005	8.701e-005	8.389e-005	8.409e-005	2.993e-005	6.926e-006	9.561e-006	1.814e-005	2.444e-003	2.345e-003	1.878e-003	2.161e-003
0.500	1.501e-003	4.562e-005	5.450e-005	5.547e-005	4.731e-005	1.915e-005	4.790e-006	6.241e-006	9.995e-006	1.602e-003	1.599e-003	1.236e-003	1.467e-003
0.600	1.030e-003	2.978e-005	3.685e-005	3.905e-005	2.990e-005	1.352e-005	3.548e-006	4.440e-006	6.105e-006	1.069e-003	1.136e-003	8.274e-004	1.021e-003
0.700	7.192e-004	2.053e-005	2.628e-005	2.874e-005	2.044e-005	1.018e-005	2.738e-006	3.325e-006	4.039e-006	7.205e-004	8.299e-004	5.596e-004	7.193e-004
0.800	5.083e-004	1.473e-005	1.947e-005	2.186e-005	1.476e-005	7.984e-006	2.173e-006	2.576e-006	2.843e-006	4.880e-004	6.196e-004	3.812e-004	5.089e-004
1.000	2.614e-004	8.279e-006	1.159e-005	1.359e-005	8.572e-006	5.317e-006	1.450e-006	1.651e-006	1.615e-006	2.262e-004	3.625e-004	1.796e-004	2.559e-004
1.200	1.395e-004	5.062e-006	7.440e-006	9.040e-006	5.450e-006	3.774e-006	1.018e-006	1.121e-006	1.038e-006	1.063e-004	2.226e-004	8.625e-005	1.286e-004
1.500	5.807e-005	2.694e-006	4.193e-006	5.343e-006	3.050e-006	2.420e-006	6.391e-007	6.717e-007	6.146e-007	3.467e-005	1.145e-004	2.906e-005	4.583e-005
2.000	1.612e-005	1.135e-006	1.880e-006	2.572e-006	1.343e-006	1.282e-006	3.275e-007	3.206e-007	3.096e-007	5.265e-006	4.241e-005	4.768e-006	8.173e-006
3.000	2.139e-006	2.915e-007	5.107e-007	7.916e-007	3.414e-007	4.300e-007	1.057e-007	9.188e-008	1.033e-007	2.537e-306	7.434e-006	2.537e-306	5.154e-015
4.000	4.017e-007	9.072e-008	1.608e-007	2.787e-007	9.878e-008	1.528e-007	3.741e-008	2.949e-008	3.757e-008	2.537e-306	1.235e-006	2.537e-306	2.537e-306
5.000	2.953e-008	2.568e-008	4.459e-008	8.511e-008	2.505e-008	4.554e-008	1.134e-008	8.387e-009	1.158e-008	2.537e-306	1.122e-008	2.537e-306	2.537e-306
7.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 0.15
  Column 1: Acceleration (g)
  Column 2: Mean
  Column 3: Frankel (1996) USGS 2008 Truncated Mw
  Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
  Column 5: Silva et al (2002) USGS 2008 Mw
  Column 6: Campbell (2003) USGS 2008 Mw
  Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
  Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
  Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
  Column 10: Atkinson (2008p) USGS 2014 Table Soil
  Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
  Column 12: Boore-et al (2014) NGA West 2 USGS 2014
  Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14

 1.0e-004 1.817e-001 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 1.723e-001
1.723e-001 1.723e-001 1.723e-001
 5.0e-004 1.814e-001 9.430e-003 9.428e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.426e-003 1.720e-001
1.722e-001 1.719e-001 1.718e-001
 1.0e-003 1.793e-001 9.430e-003 9.404e-003 9.430e-003 9.426e-003 9.417e-003 9.424e-003 9.361e-003 1.701e-001
1.713e-001 1.693e-001 1.689e-001
 5.0e-003 1.430e-001 9.298e-003 9.310e-003 8.143e-003 9.411e-003 8.638e-003 7.809e-003 8.404e-003 6.958e-003 1.355e-001
1.456e-001 1.289e-001 1.281e-001
 7.0e-003 1.277e-001 9.089e-003 9.109e-003 7.331e-003 9.356e-003 7.915e-003 6.653e-003 7.521e-003 5.861e-003 1.212e-001
1.325e-001 1.132e-001 1.128e-001
    0.010 1.098e-001 8.638e-003 8.663e-003 6.248e-003 9.182e-003 6.816e-003 5.168e-003 6.236e-003 4.654e-003 1.047e-001
1.162e-001 9.558e-002 9.572e-002
    0.020 7.474e-002 6.807e-003 6.786e-003 3.899e-003 8.007e-003 4.137e-003 2.410e-003 3.351e-003 2.607e-003 7.297e-002
8.121e-002 6.298e-002 6.401e-002
    0.050 3.716e-002 3.248e-003 3.109e-003 1.507e-003 4.270e-003 1.356e-003 5.090e-004 8.399e-004 9.169e-004 3.903e-002
4.042e-002 3.041e-002 3.178e-002
    0.070 2.714e-002 2.156e-003 2.008e-003 9.776e-004 2.823e-003 7.946e-004 2.493e-004 4.344e-004 5.617e-004 2.961e-002
2.923e-002 2.203e-002 2.332e-002
    0.100 1.880e-002 1.292e-003 1.162e-003 5.914e-004 1.618e-003 4.207e-004 1.099e-004 2.002e-004 3.078e-004 2.142e-002
1.990e-002 1.513e-002 1.629e-002
    0.200 8.378e-003 3.894e-004 3.252e-004 1.988e-004 3.921e-004 1.013e-004 2.121e-005 3.972e-005 7.263e-005 1.033e-002
8.452e-003 6.654e-003 7.438e-003
    0.300 4.924e-003 1.735e-004 1.407e-004 9.836e-005 1.444e-004 4.133e-005 8.892e-006 1.568e-005 2.618e-005 6.287e-003
4.833e-003 3.882e-003 4.431e-003
    0.400 3.243e-003 9.386e-005 7.577e-005 5.788e-005 6.840e-005 2.238e-005 5.135e-006 8.444e-006 1.187e-005 4.237e-003
3.145e-003 2.505e-003 2.950e-003
    0.500 2.257e-003 5.697e-005 4.634e-005 3.764e-005 3.846e-005 1.434e-005 3.435e-006 5.348e-006 6.271e-006 3.007e-003
2.187e-003 1.675e-003 2.075e-003
    0.600 1.616e-003 3.730e-005 3.074e-005 2.612e-005 2.424e-005 1.017e-005 2.481e-006 3.719e-006 3.702e-006 2.191e-003
1.580e-003 1.134e-003 1.504e-003
    0.700 1.177e-003 2.576e-005 2.156e-005 1.897e-005 1.651e-005 7.670e-006 1.875e-006 2.736e-006 2.377e-006 1.617e-003
1.172e-003 7.708e-004 1.107e-003
    0.800 8.656e-004 1.852e-005 1.575e-005 1.427e-005 1.188e-005 6.016e-006 1.461e-006 2.090e-006 1.629e-006 1.201e-003
8.857e-004 5.250e-004 8.216e-004
    1.000 4.782e-004 1.044e-005 9.154e-006 8.691e-006 6.858e-006 3.976e-006 9.424e-007 1.311e-006 8.779e-007 6.674e-004
5.268e-004 2.449e-004 4.567e-004
    1.200 2.697e-004 6.400e-006 5.760e-006 5.684e-006 4.333e-006 2.785e-006 6.431e-007 8.743e-007 5.348e-007 3.719e-004
3.266e-004 1.148e-004 2.546e-004
    1.500 1.182e-004 3.415e-006 3.170e-006 3.287e-006 2.399e-006 1.744e-006 3.888e-007 5.123e-007 2.915e-007 1.552e-004
1.686e-004 3.695e-005 1.059e-004
    2.000 3.275e-005 1.442e-006 1.378e-006 1.537e-006 1.035e-006 8.857e-007 1.890e-007 2.372e-007 1.292e-007 3.643e-005
6.223e-005 4.955e-006 2.459e-005
    3.000 3.414e-006 3.732e-007 3.571e-007 4.526e-007 2.517e-007 2.756e-007 5.642e-008 6.549e-008 3.514e-008 1.547e-006
1.054e-005 2.537e-306 7.985e-007
    4.000 5.173e-007 1.168e-007 1.081e-007 1.538e-007 6.900e-008 9.204e-008 1.868e-008 2.068e-008 1.097e-008 2.537e-306
1.829e-006 2.537e-306 2.537e-306
    5.000 2.015e-008 3.303e-008 2.897e-008 4.563e-008 1.678e-008 2.617e-008 5.356e-009 5.846e-009 2.847e-009 2.537e-306
1.431e-008 2.537e-306 2.537e-306
    7.000 2.893e-306 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 2.537e-306
2.537e-306 2.537e-306 2.537e-306
   10.000 2.893e-306 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 2.537e-306
2.537e-306 2.537e-306 2.537e-306

SPECTRAL PERIOD: 0.2
- **Column 1: Acceleration (g)**
- **Column 2: Mean**
- **Column 3: Frankel (1996) USGS 2008 Truncated Mw**
- **Column 4: Toro (1999) Midcontinent - USGS 2008 Mw**
- **Column 5: Silva et al (2002) USGS 2008 Mw**
- **Column 6: Campbell (2003) USGS 2008 Mw**
- **Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw**
- **Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil**
- **Column 9: Pezeshk et al (2011) USGS 2014 Table Soil**
- **Column 10: Atkinson (2008p) USGS 2014 Table Soil**
- **Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014**
- **Column 12: Boore-et al (2014) NGA West 2 USGS 2014**
- **Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014**
- **Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014**

       1   2   3   4   5   6   7   8   9   10   11
12   13   14
 1.0e-004 1.817e-001 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 1.723e-001
1.723e-001 1.723e-001 1.723e-001
 5.0e-004 1.816e-001 9.430e-003 9.430e-003 9.427e-003 9.430e-003 9.430e-003 9.430e-003 9.430e-003 9.424e-003 1.722e-001
1.723e-001 1.722e-001 1.721e-001
 1.0e-003 1.805e-001 9.430e-003 9.430e-003 9.392e-003 9.430e-003 9.429e-003 9.413e-003 9.423e-003 9.344e-003 1.710e-001
1.718e-001 1.709e-001 1.707e-001
 5.0e-003 1.511e-001 9.329e-003 9.319e-003 7.857e-003 9.399e-003 8.909e-003 7.573e-003 8.336e-003 6.709e-003 1.419e-001
1.508e-001 1.392e-001 1.389e-001
 7.0e-003 1.365e-001 9.159e-003 9.128e-003 6.952e-003 9.320e-003 8.327e-003 6.351e-003 7.419e-003 5.580e-003 1.283e-001
1.384e-001 1.244e-001 1.244e-001
    0.010 1.188e-001 8.774e-003 8.696e-003 5.801e-003 9.090e-003 7.342e-003 4.849e-003 6.107e-003 4.370e-003 1.120e-001
1.224e-001 1.067e-001 1.072e-001
    0.020 8.222e-002 7.097e-003 6.840e-003 3.461e-003 7.699e-003 4.601e-003 2.205e-003 3.238e-003 2.387e-003 7.941e-002
8.713e-002 7.181e-002 7.300e-002
    0.050 4.160e-002 3.548e-003 3.125e-003 1.267e-003 3.834e-003 1.450e-003 4.647e-004 8.100e-004 8.108e-004 4.331e-002
4.458e-002 3.513e-002 3.662e-002
    0.070 3.060e-002 2.394e-003 2.006e-003 8.079e-004 2.469e-003 8.162e-004 2.287e-004 4.210e-004 4.883e-004 3.314e-002
3.256e-002 2.554e-002 2.697e-002

0.100	2.134e-002	1.458e-003	1.149e-003	4.808e-004	1.381e-003	4.095e-004	1.008e-004	1.952e-004	2.618e-004	2.421e-002	2.235e-002	1.759e-002	1.890e-002
0.200	9.636e-003	4.495e-004	3.107e-004	1.569e-004	3.240e-004	8.998e-005	1.865e-005	3.866e-005	5.826e-005	1.194e-002	9.555e-003	7.759e-003	8.702e-003
0.300	5.741e-003	2.020e-004	1.307e-004	7.622e-005	1.178e-004	3.604e-005	7.421e-006	1.486e-005	2.005e-005	7.408e-003	5.509e-003	4.560e-003	5.250e-003
0.400	3.857e-003	1.098e-004	6.886e-005	4.423e-005	5.543e-005	1.949e-005	4.125e-006	7.772e-006	8.752e-006	5.100e-003	3.644e-003	2.999e-003	3.561e-003
0.500	2.751e-003	6.682e-005	4.140e-005	2.843e-005	3.084e-005	1.249e-005	2.690e-006	4.809e-006	4.471e-006	3.719e-003	2.585e-003	2.059e-003	2.567e-003
0.600	2.026e-003	4.384e-005	2.707e-005	1.953e-005	1.920e-005	8.823e-006	1.906e-006	3.285e-006	2.559e-006	2.801e-003	1.905e-003	1.434e-003	1.917e-003
0.700	1.521e-003	3.033e-005	1.876e-005	1.407e-005	1.291e-005	6.616e-006	1.419e-006	2.385e-006	1.598e-006	2.148e-003	1.437e-003	1.003e-003	1.463e-003
0.800	1.155e-003	2.184e-005	1.356e-005	1.050e-005	9.184e-006	5.152e-006	1.090e-006	1.803e-006	1.066e-006	1.663e-003	1.101e-003	7.020e-004	1.130e-003
1.000	6.810e-004	1.235e-005	7.743e-006	6.313e-006	5.189e-006	3.349e-006	6.867e-007	1.114e-006	5.470e-007	1.009e-003	6.687e-004	3.442e-004	6.881e-004
1.200	4.089e-004	7.584e-006	4.804e-006	4.083e-006	3.218e-006	2.306e-006	4.592e-007	7.350e-007	3.185e-007	6.145e-004	4.194e-004	1.691e-004	4.233e-004
1.500	1.948e-004	4.056e-006	2.598e-006	2.328e-006	1.737e-006	1.407e-006	2.702e-007	4.249e-007	1.634e-007	2.923e-004	2.178e-004	5.845e-005	2.056e-004
2.000	5.945e-005	1.717e-006	1.104e-006	1.068e-006	7.215e-007	6.843e-007	1.267e-007	1.937e-007	6.649e-008	8.493e-005	7.963e-005	9.064e-006	6.191e-005
3.000	6.446e-006	4.461e-007	2.765e-007	3.049e-007	1.629e-007	1.958e-007	3.561e-008	5.231e-008	1.577e-008	6.749e-006	1.281e-005	1.030e-009	5.639e-006
4.000	5.706e-007	1.404e-007	8.117e-008	1.013e-007	4.172e-008	6.073e-008	1.128e-008	1.636e-008	4.321e-009	1.021e-008	2.077e-006	2.537e-306	1.790e-008
5.000	1.339e-008	3.980e-008	2.119e-008	2.949e-008	9.645e-009	1.629e-008	3.126e-009	4.414e-009	1.092e-009	2.537e-306	6.127e-009	2.537e-306	2.537e-306
7.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 0.25

- Column 1: Acceleration (g)
- Column 2: Mean
- Column 3: Frankel (1996) USGS 2008 Truncated Mw
- Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
- Column 5: Silva et al (2002) USGS 2008 Mw
- Column 6: Campbell (2003) USGS 2008 Mw
- Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
- Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
- Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
- Column 10: Atkinson (2008p) USGS 2014 Table Soil
- Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
- Column 12: Boore-et al (2014) NGA West 2 USGS 2014
- Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
- Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001
5.0e-004	1.817e-001	9.430e-003	9.430e-003	9.422e-003	9.430e-003	9.430e-003	9.428e-003	9.430e-003	9.413e-003	1.722e-001	1.723e-001	1.723e-001	1.722e-001
1.0e-003	1.809e-001	9.430e-003	9.430e-003	9.351e-003	9.430e-003	9.430e-003	9.385e-003	9.414e-003	9.240e-003	1.713e-001	1.720e-001	1.716e-001	1.712e-001
5.0e-003	1.548e-001	9.280e-003	9.225e-003	7.279e-003	9.368e-003	9.068e-003	6.773e-003	7.864e-003	5.840e-003	1.445e-001	1.522e-001	1.463e-001	1.443e-001
7.0e-003	1.407e-001	9.049e-003	8.925e-003	6.257e-003	9.231e-003	8.621e-003	5.421e-003	6.769e-003	4.688e-003	1.311e-001	1.398e-001	1.326e-001	1.306e-001
0.010	1.230e-001	8.562e-003	8.317e-003	5.053e-003	8.874e-003	7.809e-003	3.939e-003	5.344e-003	3.550e-003	1.147e-001	1.235e-001	1.154e-001	1.136e-001
0.020	8.556e-002	6.649e-003	6.102e-003	2.836e-003	7.078e-003	5.288e-003	1.662e-003	2.611e-003	1.830e-003	8.135e-002	8.742e-002	7.931e-002	7.838e-002
0.050	4.336e-002	3.095e-003	2.486e-003	9.765e-004	3.099e-003	1.902e-003	3.338e-004	6.080e-004	5.621e-004	4.418e-002	4.473e-002	3.928e-002	3.948e-002
0.070	3.191e-002	2.038e-003	1.538e-003	6.120e-004	1.903e-003	1.125e-003	1.627e-004	3.117e-004	3.207e-004	3.375e-002	3.273e-002	2.861e-002	2.906e-002
0.100	2.226e-002	1.213e-003	8.526e-004	3.587e-004	1.018e-003	5.925e-004	7.077e-005	1.439e-004	1.606e-004	2.461e-002	2.248e-002	1.971e-002	2.036e-002
0.200	1.003e-002	3.610e-004	2.205e-004	1.137e-004	2.243e-004	1.355e-004	1.263e-005	2.814e-005	3.050e-005	1.209e-002	9.562e-003	8.638e-003	9.377e-003
0.300	5.985e-003	1.593e-004	9.146e-005	5.414e-005	8.028e-005	5.165e-005	4.903e-006	1.059e-005	9.500e-006	7.501e-003	5.508e-003	5.059e-003	5.688e-003
0.400	4.046e-003	8.533e-005	4.767e-005	3.093e-005	3.766e-005	2.582e-005	2.677e-006	5.422e-006	3.886e-006	5.186e-003	3.656e-003	3.353e-003	3.896e-003
0.500	2.918e-003	5.123e-005	2.833e-005	1.962e-005	2.091e-005	1.536e-005	1.715e-006	3.289e-006	1.901e-006	3.813e-003	2.609e-003	2.346e-003	2.849e-003
0.600	2.181e-003	3.318e-005	1.831e-005	1.333e-005	1.300e-005	1.025e-005	1.194e-006	2.206e-006	1.060e-006	2.909e-003	1.935e-003	1.680e-003	2.166e-003
0.700	1.666e-003	2.268e-005	1.255e-005	9.514e-006	8.730e-006	7.395e-006	8.725e-007	1.575e-006	6.501e-007	2.268e-003	1.468e-003	1.214e-003	1.688e-003
0.800	1.289e-003	1.615e-005	8.981e-006	7.040e-006	6.194e-006	5.619e-006	6.588e-007	1.173e-006	4.274e-007	1.791e-003	1.130e-003	8.814e-004	1.336e-003
1.000	7.918e-004	8.952e-006	5.041e-006	4.174e-006	3.472e-006	3.574e-006	4.015e-007	7.041e-007	2.133e-007	1.138e-003	6.907e-004	4.664e-004	8.615e-004

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    1.200  4.961e-004  5.407e-006  3.083e-006  2.669e-006  2.125e-006  2.453e-006  2.607e-007  4.523e-007  1.204e-007  7.302e-004
4.347e-004  2.477e-004  5.654e-004
    1.500  2.518e-004  2.834e-006  1.638e-006  1.502e-006  1.120e-006  1.511e-006  1.475e-007  2.527e-007  5.871e-008  3.764e-004
2.259e-004  9.650e-005  3.046e-004
    2.000  8.464e-005  1.170e-006  6.801e-007  6.770e-007  4.451e-007  7.576e-007  6.520e-008  1.102e-007  2.182e-008  1.252e-004
8.197e-005  1.973e-005  1.101e-004
    3.000  1.056e-005  2.938e-007  1.645e-007  1.888e-007  9.125e-008  2.336e-007  1.666e-008  2.786e-008  4.438e-009  1.383e-005
1.281e-005  2.090e-007  1.501e-005
    4.000  1.197e-006  9.069e-008  4.742e-008  6.185e-008  2.146e-008  7.786e-008  4.913e-009  8.058e-009  1.157e-009  9.970e-007
1.948e-006  2.537e-306  1.721e-006
    5.000  9.043e-009  2.548e-008  1.235e-008  1.796e-008  4.733e-009  2.221e-008  1.290e-009  2.086e-009  2.898e-010  2.537e-306
2.597e-009  2.537e-306  6.040e-015
    7.000  2.893e-306  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
   10.000  2.893e-306  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306

SPECTRAL PERIOD: 0.3
  Column 1: Acceleration (g)
  Column 2: Mean
  Column 3: Frankel (1996) USGS 2008 Truncated Mw
  Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
  Column 5: Silva et al (2002) USGS 2008 Mw
  Column 6: Campbell (2003) USGS 2008 Mw
  Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
  Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
  Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
  Column 10: Atkinson (2008p) USGS 2014 Table Soil
  Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
  Column 12: Boore-et al (2014) NGA West 2 USGS 2014
  Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

        1           2           3           4           5           6           7           8           9          10          11
12          13          14
 1.0e-004  1.817e-001  9.430e-003  9.430e-003  9.430e-003  9.430e-003  9.430e-003  9.430e-003  9.430e-003  9.430e-003  1.723e-001
1.723e-001  1.723e-001  1.723e-001
 5.0e-004  1.817e-001  9.430e-003  9.430e-003  9.414e-003  9.430e-003  9.430e-003  9.425e-003  9.429e-003  9.391e-003  1.722e-001
1.723e-001  1.723e-001  1.722e-001
 1.0e-003  1.810e-001  9.430e-003  9.295e-003  9.430e-003  9.430e-003  9.338e-003  9.401e-003  9.093e-003  1.713e-001
1.720e-001  1.718e-001  1.714e-001
 5.0e-003  1.559e-001  9.225e-003  9.105e-003  6.748e-003  9.324e-003  9.165e-003  6.046e-003  7.401e-003  5.106e-003  1.440e-001
1.521e-001  1.505e-001  1.465e-001
 7.0e-003  1.419e-001  8.935e-003  8.690e-003  5.660e-003  9.118e-003  8.810e-003  4.664e-003  6.184e-003  3.991e-003  1.302e-001
1.393e-001  1.379e-001  1.331e-001
    0.010  1.242e-001  8.355e-003  7.922e-003  4.452e-003  8.629e-003  8.130e-003  3.272e-003  4.718e-003  2.947e-003  1.134e-001
1.224e-001  1.215e-001  1.163e-001
    0.020  8.632e-002  6.258e-003  5.464e-003  2.386e-003  6.500e-003  5.826e-003  1.318e-003  2.169e-003  1.452e-003  7.961e-002
8.555e-002  8.510e-002  8.054e-002
    0.050  4.355e-002  2.751e-003  2.038e-003  7.855e-004  2.563e-003  2.321e-003  2.578e-004  4.827e-004  4.065e-004  4.267e-002
4.341e-002  4.259e-002  4.041e-002
    0.070  3.199e-002  1.779e-003  1.230e-003  4.863e-004  1.520e-003  1.430e-003  1.244e-004  2.457e-004  2.206e-004  3.245e-002
3.173e-002  3.104e-002  2.965e-002
    0.100  2.226e-002  1.042e-003  6.672e-004  2.816e-004  7.882e-004  7.864e-004  5.328e-005  1.133e-004  1.039e-004  2.356e-002
2.176e-002  2.139e-002  2.068e-002
    0.200  9.974e-003  3.019e-004  1.683e-004  8.711e-005  1.667e-004  1.918e-004  9.135e-006  2.169e-005  1.713e-005  1.149e-002
9.214e-003  9.337e-003  9.461e-003
    0.300  5.944e-003  1.313e-004  6.918e-005  4.081e-005  5.917e-005  7.302e-005  3.462e-006  7.979e-006  4.902e-006  7.119e-003
5.311e-003  5.452e-003  5.737e-003
    0.400  4.032e-003  6.944e-005  3.572e-005  2.303e-005  2.765e-005  3.518e-005  1.860e-006  4.003e-006  1.899e-006  4.938e-003
3.541e-003  3.625e-003  3.944e-003
    0.500  2.928e-003  4.122e-005  2.102e-005  1.447e-005  1.533e-005  1.984e-005  1.174e-006  2.387e-006  9.014e-007  3.656e-003
2.540e-003  2.569e-003  2.902e-003
    0.600  2.212e-003  2.640e-005  1.347e-005  9.751e-006  9.529e-006  1.257e-005  8.049e-007  1.578e-006  4.945e-007  2.818e-003
1.894e-003  1.880e-003  2.226e-003
    0.700  1.711e-003  1.788e-005  9.164e-006  6.912e-006  6.398e-006  8.663e-006  5.793e-007  1.112e-006  2.996e-007  2.227e-003
1.444e-003  1.401e-003  1.754e-003
    0.800  1.345e-003  1.262e-005  6.513e-006  5.086e-006  4.533e-006  6.359e-006  4.309e-007  8.181e-007  1.951e-007  1.788e-003
1.118e-003  1.054e-003  1.407e-003
    1.000  8.559e-004  6.887e-006  3.614e-006  2.988e-006  2.520e-006  3.884e-006  2.558e-007  4.801e-007  9.503e-008  1.183e-003
6.897e-004  6.072e-004  9.359e-004
    1.200  5.573e-004  4.108e-006  2.190e-006  1.897e-006  1.524e-006  2.626e-006  1.621e-007  3.027e-007  5.225e-008  7.946e-004
4.376e-004  3.547e-004  6.371e-004
    1.500  3.000e-004  2.120e-006  1.151e-006  1.058e-006  7.856e-007  1.616e-006  8.863e-008  1.653e-007  2.434e-008  4.418e-004
2.296e-004  1.614e-004  3.646e-004
    2.000  1.112e-004  8.591e-007  4.709e-007  4.719e-007  2.985e-007  8.261e-007  3.723e-008  6.971e-008  8.556e-009  1.678e-004
8.407e-005  4.497e-005  1.468e-004
    3.000  1.678e-005  2.106e-007  1.115e-007  1.299e-007  5.578e-008  2.695e-007  8.792e-009  1.663e-008  1.639e-009  2.508e-005
1.327e-005  3.348e-006  2.511e-005
    4.000  2.458e-006  6.389e-008  3.154e-008  4.219e-008  1.198e-008  9.490e-008  2.421e-009  4.681e-009  4.094e-010  3.405e-006
2.026e-006  2.076e-015  4.296e-006
    5.000  7.293e-008  1.773e-008  7.962e-009  1.201e-008  2.232e-009  2.831e-008  5.892e-010  1.193e-009  9.243e-011  1.509e-008
2.074e-009  2.537e-306  2.460e-007
    7.000  2.893e-306  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
   10.000  2.893e-306  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306

SPECTRAL PERIOD: 0.4
  Column 1: Acceleration (g)
```

Column 2: Mean
Column 3: Frankel (1996) USGS 2008 Truncated Mw
Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
Column 5: Silva et al (2002) USGS 2008 Mw
Column 6: Campbell (2003) USGS 2008 Mw
Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
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Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001
5.0e-004	1.817e-001	9.430e-003	9.430e-003	9.379e-003	9.430e-003	9.429e-003	9.403e-003	9.419e-003	9.264e-003	1.723e-001	1.723e-001	1.723e-001	1.722e-001
1.0e-003	1.809e-001	9.429e-003	9.427e-003	9.111e-003	9.430e-003	9.409e-003	9.141e-003	9.290e-003	8.513e-003	1.715e-001	1.719e-001	1.718e-001	1.714e-001
5.0e-003	1.531e-001	8.953e-003	8.687e-003	5.690e-003	8.990e-003	7.882e-003	4.668e-003	5.790e-003	3.682e-003	1.443e-001	1.479e-001	1.475e-001	1.461e-001
7.0e-003	1.381e-001	8.435e-003	7.979e-003	4.570e-003	8.440e-003	6.868e-003	3.394e-003	4.431e-003	2.753e-003	1.300e-001	1.335e-001	1.338e-001	1.326e-001
0.010	1.194e-001	7.561e-003	6.879e-003	3.441e-003	7.466e-003	5.560e-003	2.264e-003	3.086e-003	1.953e-003	1.125e-001	1.152e-001	1.164e-001	1.155e-001
0.020	8.102e-002	5.079e-003	4.144e-003	1.720e-003	4.665e-003	2.986e-003	8.586e-004	1.234e-003	8.864e-004	7.747e-002	7.804e-002	7.949e-002	7.939e-002
0.050	3.987e-002	1.944e-003	1.314e-003	5.344e-004	1.448e-003	8.676e-004	1.597e-004	2.509e-004	2.094e-004	4.046e-002	3.848e-002	3.862e-002	3.905e-002
0.070	2.905e-002	1.212e-003	7.603e-004	3.261e-004	8.114e-004	4.920e-004	7.507e-005	1.263e-004	1.049e-004	3.049e-002	2.783e-002	2.789e-002	2.837e-002
0.100	2.006e-002	6.875e-004	3.988e-004	1.861e-004	4.045e-004	2.516e-004	3.113e-005	5.725e-005	4.512e-005	2.190e-002	1.884e-002	1.907e-002	1.958e-002
0.200	8.892e-003	1.903e-004	9.718e-005	5.553e-005	8.329e-005	5.421e-005	5.040e-006	1.053e-005	6.223e-006	1.042e-002	7.832e-003	8.318e-003	8.809e-003
0.300	5.298e-003	8.035e-005	3.911e-005	2.532e-005	2.907e-005	1.947e-005	1.883e-006	3.783e-006	1.650e-006	6.364e-003	4.509e-003	4.914e-003	5.327e-003
0.400	3.607e-003	4.132e-005	1.976e-005	1.397e-005	1.332e-005	9.320e-006	1.001e-006	1.868e-006	6.252e-007	4.390e-003	3.008e-003	3.318e-003	3.675e-003
0.500	2.637e-003	2.390e-005	1.141e-005	8.617e-006	7.252e-006	5.381e-006	6.222e-007	1.095e-006	3.009e-007	3.252e-003	2.154e-003	2.395e-003	2.723e-003
0.600	2.010e-003	1.497e-005	7.182e-006	5.719e-006	4.432e-006	3.513e-006	4.181e-007	7.104e-007	1.681e-007	2.520e-003	1.601e-003	1.795e-003	2.109e-003
0.700	1.574e-003	9.934e-006	4.809e-006	3.999e-006	2.929e-006	2.484e-006	2.946e-007	4.910e-007	1.031e-007	2.011e-003	1.217e-003	1.375e-003	1.683e-003
0.800	1.255e-003	6.889e-006	3.372e-006	2.909e-006	2.041e-006	1.848e-006	2.147e-007	3.536e-007	6.724e-008	1.637e-003	9.388e-004	1.069e-003	1.370e-003
1.000	8.272e-004	3.651e-006	1.830e-006	1.676e-006	1.098e-006	1.125e-006	1.225e-007	1.996e-007	3.221e-008	1.123e-003	5.757e-004	6.642e-004	9.426e-004
1.200	5.613e-004	2.128e-006	1.090e-006	1.048e-006	6.420e-007	7.372e-007	7.468e-008	1.214e-007	1.706e-008	7.899e-004	3.633e-004	4.226e-004	6.672e-004
1.500	3.237e-004	1.072e-006	5.607e-007	5.743e-007	3.140e-007	4.239e-007	3.879e-008	6.315e-008	7.542e-009	4.760e-004	1.894e-004	2.211e-004	4.071e-004
2.000	1.358e-004	4.246e-007	2.239e-007	2.506e-007	1.100e-007	1.907e-007	1.511e-008	2.473e-008	2.419e-009	2.105e-004	6.860e-005	7.957e-005	1.840e-004
3.000	2.672e-005	1.024e-007	5.129e-008	6.692e-008	1.748e-008	4.816e-008	3.070e-009	5.300e-009	3.890e-010	4.431e-005	1.057e-005	1.172e-005	4.016e-005
4.000	5.507e-006	3.093e-008	1.426e-008	2.117e-008	3.079e-009	1.355e-008	7.149e-010	1.351e-009	6.952e-011	9.693e-006	1.455e-006	1.569e-006	9.282e-006
5.000	9.245e-007	8.559e-009	3.600e-009	5.963e-009	4.631e-010	3.356e-009	1.459e-010	3.058e-010	7.827e-012	1.835e-006	1.307e-009	2.169e-013	1.853e-006
7.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 0.5
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Frankel (1996) USGS 2008 Truncated Mw
Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
Column 5: Silva et al (2002) USGS 2008 Mw
Column 6: Campbell (2003) USGS 2008 Mw
Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
Column 10: Atkinson (2008p) USGS 2014 Table Soil
Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 12: Boore-et al (2014) NGA West 2 USGS 2014
Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.430e-003	9.429e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001

 5.0e-004 1.816e-001 9.430e-003 9.430e-003 9.319e-003 9.430e-003 9.412e-003 9.351e-003 9.385e-003 9.010e-003 1.722e-001
1.723e-001 1.723e-001 1.722e-001
 1.0e-003 1.804e-001 9.425e-003 9.419e-003 8.864e-003 9.425e-003 9.255e-003 8.825e-003 9.050e-003 7.752e-003 1.713e-001
1.716e-001 1.716e-001 1.711e-001
 5.0e-003 1.479e-001 8.596e-003 8.163e-003 4.853e-003 8.411e-003 5.938e-003 3.692e-003 4.452e-003 2.757e-003 1.405e-001
1.418e-001 1.441e-001 1.428e-001
 7.0e-003 1.319e-001 7.870e-003 7.212e-003 3.779e-003 7.514e-003 4.693e-003 2.597e-003 3.206e-003 2.008e-003 1.252e-001
1.261e-001 1.295e-001 1.287e-001
    0.010 1.127e-001 6.787e-003 5.916e-003 2.763e-003 6.215e-003 3.430e-003 1.690e-003 2.115e-003 1.388e-003 1.070e-001
1.073e-001 1.114e-001 1.112e-001
    0.020 7.498e-002 4.192e-003 3.219e-003 1.323e-003 3.368e-003 1.565e-003 6.234e-004 7.916e-004 5.889e-004 7.208e-002
7.114e-002 7.457e-002 7.524e-002
    0.050 3.623e-002 1.472e-003 9.258e-004 3.975e-004 9.221e-004 3.984e-004 1.111e-004 1.555e-004 1.213e-004 3.690e-002
3.449e-002 3.539e-002 3.628e-002
    0.070 2.624e-002 8.982e-004 5.242e-004 2.403e-004 5.058e-004 2.171e-004 5.093e-005 7.707e-005 5.727e-005 2.763e-002
2.478e-002 2.536e-002 2.615e-002
    0.100 1.800e-002 5.001e-004 2.713e-004 1.355e-004 2.494e-004 1.053e-004 2.050e-005 3.418e-005 2.302e-005 1.968e-002
1.666e-002 1.722e-002 1.790e-002
    0.200 7.908e-003 1.337e-004 6.476e-005 3.927e-005 5.014e-005 2.017e-005 3.165e-006 5.997e-006 2.826e-006 9.165e-003
6.922e-003 7.473e-003 7.953e-003
    0.300 4.705e-003 5.489e-005 2.554e-005 1.754e-005 1.709e-005 7.074e-006 1.173e-006 2.109e-006 7.153e-007 5.519e-003
4.014e-003 4.433e-003 4.806e-003
    0.400 3.204e-003 2.757e-005 1.270e-005 9.525e-006 7.715e-006 3.473e-006 6.201e-007 1.028e-006 2.732e-007 3.769e-003
2.690e-003 3.008e-003 3.327e-003
    0.500 2.345e-003 1.565e-005 7.230e-006 5.803e-006 4.172e-006 2.067e-006 3.803e-007 5.963e-007 1.339e-007 2.770e-003
1.932e-003 2.185e-003 2.479e-003
    0.600 1.791e-003 9.646e-006 4.501e-006 3.814e-006 2.540e-006 1.371e-006 2.511e-007 3.827e-007 7.520e-008 2.132e-003
1.440e-003 1.650e-003 1.935e-003
    0.700 1.407e-003 6.319e-006 2.989e-006 2.646e-006 1.671e-006 9.701e-007 1.738e-007 2.606e-007 4.577e-008 1.690e-003
1.098e-003 1.277e-003 1.558e-003
    0.800 1.127e-003 4.332e-006 2.081e-006 1.912e-006 1.158e-006 7.138e-007 1.244e-007 1.853e-007 2.936e-008 1.366e-003
8.510e-004 1.005e-003 1.281e-003
    1.000 7.497e-004 2.257e-006 1.118e-006 1.091e-006 6.133e-007 4.165e-007 6.861e-008 1.020e-007 1.341e-008 9.240e-004
5.279e-004 6.435e-004 9.013e-004
    1.200 5.144e-004 1.302e-006 6.614e-007 6.773e-007 3.512e-007 2.590e-007 4.057e-008 6.037e-008 6.844e-009 6.408e-004
3.380e-004 4.241e-004 6.536e-004
    1.500 3.025e-004 6.503e-007 3.381e-007 3.682e-007 1.663e-007 1.368e-007 2.015e-008 3.024e-008 2.861e-009 3.785e-004
1.807e-004 2.355e-004 4.146e-004
    2.000 1.319e-004 2.557e-007 1.337e-007 1.592e-007 5.473e-008 5.322e-008 7.267e-009 1.131e-008 8.408e-010 1.633e-004
6.869e-005 9.468e-005 2.006e-004
    3.000 2.841e-005 6.086e-008 3.012e-008 4.198e-008 7.387e-009 1.026e-008 1.249e-009 2.175e-009 9.564e-011 3.338e-005
1.189e-005 1.802e-005 5.029e-005
    4.000 6.518e-006 1.791e-008 8.136e-009 1.321e-008 1.046e-009 2.213e-009 2.336e-010 4.839e-010 5.647e-012 7.094e-006
2.031e-006 3.688e-006 1.324e-005
    5.000 1.176e-006 4.816e-009 1.988e-009 3.696e-009 1.079e-010 4.078e-010 3.391e-011 9.563e-011 3.560e-307 1.197e-006
3.253e-008 3.760e-007 3.094e-006
    7.000 2.893e-306 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 2.537e-306
2.537e-306 2.537e-306 2.537e-306
   10.000 2.893e-306 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 2.537e-306
2.537e-306 2.537e-306 2.537e-306

SPECTRAL PERIOD: 0.75
  Column 1: Acceleration (g)
  Column 2: Mean
  Column 3: Frankel (1996) USGS 2008 Truncated Mw
  Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
  Column 5: Silva et al (2002) USGS 2008 Mw
  Column 6: Campbell (2003) USGS 2008 Mw
  Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
  Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
  Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
  Column 10: Atkinson (2008p) USGS 2014 Table Soil
  Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
  Column 12: Boore-et al (2014) NGA West 2 USGS 2014
  Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

       1   2   3   4   5   6   7   8   9   10   11
12   13   14
 1.0e-004 1.817e-001 9.430e-003 9.430e-003 9.424e-003 9.430e-003 9.430e-003 9.428e-003 9.429e-003 9.399e-003 1.723e-001
1.723e-001 1.723e-001 1.723e-001
 5.0e-004 1.809e-001 9.422e-003 9.421e-003 8.909e-003 9.427e-003 9.326e-003 8.714e-003 8.927e-003 7.582e-003 1.717e-001
1.720e-001 1.721e-001 1.719e-001
 1.0e-003 1.771e-001 9.340e-003 9.328e-003 7.784e-003 9.372e-003 8.816e-003 6.953e-003 7.489e-003 5.421e-003 1.678e-001
1.691e-001 1.705e-001 1.692e-001
 5.0e-003 1.272e-001 6.858e-003 6.522e-003 3.130e-003 6.765e-003 4.190e-003 1.784e-003 2.056e-003 1.479e-003 1.145e-001
1.192e-001 1.331e-001 1.272e-001
 7.0e-003 1.095e-001 5.726e-003 5.283e-003 2.315e-003 5.475e-003 3.083e-003 1.190e-003 1.360e-003 1.044e-003 9.724e-002
1.017e-001 1.168e-001 1.108e-001
    0.010 9.053e-002 4.470e-003 3.951e-003 1.623e-003 4.064e-003 2.110e-003 7.421e-004 8.407e-004 6.887e-004 7.964e-002
8.355e-002 9.819e-002 9.250e-002
    0.020 5.747e-002 2.357e-003 1.855e-003 7.383e-004 1.855e-003 8.741e-004 2.518e-004 2.913e-004 2.526e-004 5.087e-002
5.312e-002 6.309e-002 5.914e-002
    0.050 2.653e-002 7.520e-004 4.881e-004 2.152e-004 4.621e-004 1.996e-004 3.746e-005 5.054e-005 3.899e-005 2.515e-002
2.452e-002 2.859e-002 2.696e-002
    0.070 1.887e-002 4.539e-004 2.746e-004 1.285e-004 2.514e-004 1.028e-004 1.583e-005 2.339e-005 1.619e-005 1.855e-002
1.719e-002 2.015e-002 1.908e-002
    0.100 1.271e-002 2.511e-004 1.420e-004 7.131e-005 1.224e-004 4.634e-005 5.884e-006 9.588e-006 5.638e-006 1.296e-002
1.131e-002 1.348e-002 1.284e-002

0.200	5.477e-003	6.546e-005	3.347e-005	1.979e-005	2.312e-005	7.649e-006	8.665e-007	1.490e-006	5.167e-007	5.808e-003	4.663e-003	5.760e-003	5.620e-003
0.300	3.253e-003	2.605e-005	1.293e-005	8.541e-006	7.482e-006	2.553e-006	3.297e-007	5.121e-007	1.221e-007	3.443e-003	2.715e-003	3.423e-003	3.410e-003
0.400	2.214e-003	1.269e-005	6.282e-006	4.511e-006	3.261e-006	1.226e-006	1.692e-007	2.486e-007	4.686e-008	2.328e-003	1.801e-003	2.338e-003	2.379e-003
0.500	1.619e-003	7.002e-006	3.499e-006	2.684e-006	1.720e-006	7.103e-007	9.777e-008	1.410e-007	2.230e-008	1.692e-003	1.270e-003	1.718e-003	1.792e-003
0.600	1.237e-003	4.199e-006	2.137e-006	1.726e-006	1.029e-006	4.529e-007	6.050e-008	8.761e-008	1.197e-008	1.281e-003	9.276e-004	1.318e-003	1.416e-003
0.700	9.713e-004	2.684e-006	1.393e-006	1.176e-006	6.678e-007	3.051e-007	3.926e-008	5.758e-008	6.923e-009	9.948e-004	6.932e-004	1.041e-003	1.153e-003
0.800	7.776e-004	1.802e-006	9.553e-007	8.363e-007	4.581e-007	2.133e-007	2.641e-008	3.930e-008	4.223e-009	7.840e-004	5.268e-004	8.392e-004	9.590e-004
1.000	5.177e-004	9.074e-007	5.007e-007	4.648e-007	2.384e-007	1.120e-007	1.288e-008	1.987e-008	1.757e-009	4.998e-004	3.157e-004	5.671e-004	6.875e-004
1.200	3.564e-004	5.105e-007	2.903e-007	2.818e-007	1.351e-007	6.255e-008	6.745e-009	1.085e-008	8.073e-010	3.251e-004	1.965e-004	3.969e-004	5.065e-004
1.500	2.121e-004	2.494e-007	1.453e-007	1.491e-007	6.358e-008	2.816e-008	2.783e-009	4.809e-009	2.743e-010	1.753e-004	1.015e-004	2.428e-004	3.286e-004
2.000	9.615e-005	9.738e-008	5.645e-008	6.244e-008	2.104e-008	8.437e-009	7.167e-010	1.435e-009	4.576e-011	6.605e-005	3.707e-005	1.157e-004	1.657e-004
3.000	2.358e-005	2.428e-008	1.281e-008	1.626e-008	3.058e-009	8.897e-010	4.536e-011	1.623e-010	3.560e-307	1.042e-005	5.932e-006	3.153e-005	4.640e-005
4.000	6.566e-006	8.587e-009	3.868e-009	5.541e-009	4.973e-010	7.622e-011	3.560e-307	1.630e-011	3.560e-307	1.409e-006	6.820e-007	9.871e-006	1.430e-005
5.000	1.910e-006	3.600e-009	1.369e-009	2.201e-009	8.034e-011	2.687e-012	3.560e-307	6.308e-013	3.560e-307	1.712e-010	1.073e-009	3.171e-006	4.466e-006
7.000	1.572e-008	8.526e-010	2.311e-010	4.645e-010	5.593e-013	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	3.340e-009	5.912e-008
10.000	1.614e-011	1.502e-010	2.246e-011	7.011e-011	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 1

- Column 1: Acceleration (g)
- Column 2: Mean
- Column 3: Frankel (1996) USGS 2008 Truncated Mw
- Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
- Column 5: Silva et al (2002) USGS 2008 Mw
- Column 6: Campbell (2003) USGS 2008 Mw
- Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
- Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
- Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
- Column 10: Atkinson (2008p) USGS 2014 Table Soil
- Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
- Column 12: Boore-et al (2014) NGA West 2 USGS 2014
- Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
- Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.817e-001	9.430e-003	9.430e-003	9.400e-003	9.430e-003	9.429e-003	9.403e-003	9.410e-003	9.237e-003	1.723e-001	1.723e-001	1.723e-001	1.723e-001
5.0e-004	1.791e-001	9.374e-003	9.385e-003	8.270e-003	9.399e-003	9.051e-003	7.455e-003	7.844e-003	5.967e-003	1.698e-001	1.707e-001	1.716e-001	1.711e-001
1.0e-003	1.708e-001	9.057e-003	9.099e-003	6.652e-003	9.143e-003	7.944e-003	5.060e-003	5.562e-003	3.839e-003	1.601e-001	1.629e-001	1.675e-001	1.656e-001
5.0e-003	1.061e-001	5.304e-003	5.170e-003	2.224e-003	4.973e-003	2.810e-003	1.058e-003	1.134e-003	9.488e-004	9.235e-002	9.718e-002	1.145e-001	1.096e-001
7.0e-003	8.867e-002	4.198e-003	3.967e-003	1.611e-003	3.720e-003	1.974e-003	6.938e-004	7.343e-004	6.480e-004	7.644e-002	8.085e-002	9.705e-002	9.255e-002
0.010	7.145e-002	3.131e-003	2.823e-003	1.113e-003	2.571e-003	1.301e-003	4.229e-004	4.467e-004	4.073e-004	6.141e-002	6.524e-002	7.871e-002	7.510e-002
0.020	4.374e-002	1.569e-003	1.248e-003	4.990e-004	1.075e-003	5.124e-004	1.336e-004	1.472e-004	1.316e-004	3.844e-002	4.055e-002	4.763e-002	4.608e-002
0.050	1.928e-002	4.913e-004	3.222e-004	1.432e-004	2.544e-004	1.083e-004	1.705e-005	2.245e-005	1.621e-005	1.841e-002	1.775e-002	2.028e-002	2.015e-002
0.070	1.349e-002	2.950e-004	1.815e-004	8.477e-005	1.348e-004	5.347e-005	6.767e-006	9.800e-006	6.103e-006	1.334e-002	1.220e-002	1.405e-002	1.407e-002
0.100	8.977e-003	1.617e-004	9.370e-005	4.648e-005	6.299e-005	2.298e-005	2.386e-006	3.790e-006	1.892e-006	9.151e-003	7.945e-003	9.298e-003	9.364e-003
0.200	3.869e-003	4.080e-005	2.179e-005	1.250e-005	1.073e-005	3.549e-006	3.533e-007	5.604e-007	1.433e-007	4.015e-003	3.337e-003	4.014e-003	4.079e-003
0.300	2.314e-003	1.579e-005	8.282e-006	5.268e-006	3.292e-006	1.162e-006	1.336e-007	1.959e-007	3.485e-008	2.373e-003	1.962e-003	2.419e-003	2.490e-003
0.400	1.579e-003	7.511e-006	3.959e-006	2.731e-006	1.396e-006	5.391e-007	6.465e-008	9.346e-008	1.325e-008	1.600e-003	1.295e-003	1.663e-003	1.753e-003
0.500	1.154e-003	4.054e-006	2.173e-006	1.598e-006	7.220e-007	2.942e-007	3.493e-008	5.168e-008	6.059e-009	1.152e-003	9.046e-004	1.224e-003	1.333e-003
0.600	8.785e-004	2.388e-006	1.310e-006	1.014e-006	4.232e-007	1.748e-007	2.023e-008	3.088e-008	3.075e-009	8.604e-004	6.528e-004	9.387e-004	1.060e-003
0.700	6.862e-004	1.504e-006	8.439e-007	6.830e-007	2.681e-007	1.095e-007	1.230e-008	1.942e-008	1.674e-009	6.559e-004	4.818e-004	7.390e-004	8.667e-004
0.800	5.456e-004	9.969e-007	5.728e-007	4.806e-007	1.786e-007	7.114e-008	7.756e-009	1.269e-008	9.571e-010	5.066e-004	3.617e-004	5.926e-004	7.207e-004
1.000	3.579e-004	4.934e-007	2.961e-007	2.620e-007	8.773e-008	3.218e-008	3.325e-009	5.871e-009	3.388e-010	3.100e-004	2.121e-004	3.955e-004	5.136e-004
1.200	2.430e-004	2.750e-007	1.700e-007	1.567e-007	4.703e-008	1.551e-008	1.521e-009	2.928e-009	1.246e-010	1.946e-004	1.292e-004	2.734e-004	3.744e-004

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    1.500  1.421e-004  1.341e-007  8.424e-008  8.128e-008  2.035e-008  5.562e-009  5.035e-010  1.125e-009  2.576e-011  1.003e-004
6.477e-005  1.645e-004  2.386e-004
    2.000  6.312e-005  5.269e-008  3.256e-008  3.332e-008  5.880e-009  1.069e-009  7.874e-011  2.614e-010  3.560e-307  3.545e-005
2.271e-005  7.660e-005  1.177e-004
    3.000  1.513e-005  1.384e-008  7.543e-009  8.424e-009  6.356e-010  2.391e-011  3.560e-307  1.323e-011  3.560e-307  4.924e-006
3.193e-006  2.014e-005  3.226e-005
    4.000  4.100e-006  5.109e-009  2.373e-009  2.867e-009  7.803e-011  3.560e-307  3.560e-307  7.705e-014  3.560e-307  3.116e-007
1.537e-007  6.083e-006  9.848e-006
    5.000  1.165e-006  2.209e-009  8.813e-010  1.164e-009  7.612e-012  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
3.642e-010  1.708e-006  2.952e-006
    7.000  2.518e-009  5.629e-010  1.694e-010  2.574e-010  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  8.611e-013  9.787e-009
   10.000  1.115e-011  1.026e-010  1.883e-011  4.239e-011  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306

SPECTRAL PERIOD: 1.5
  Column 1: Acceleration (g)
  Column 2: Mean
  Column 3: Frankel (1996) USGS 2008 Truncated Mw
  Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
  Column 5: Silva et al (2002) USGS 2008 Mw
  Column 6: Campbell (2003) USGS 2008 Mw
  Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
  Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
  Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
  Column 10: Atkinson (2008p) USGS 2014 Table Soil
  Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
  Column 12: Boore-et al (2014) NGA West 2 USGS 2014
  Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

       1           2           3           4           5           6           7           8           9          10          11
12          13          14
 1.0e-004  1.814e-001  9.424e-003  9.427e-003  9.145e-003  9.430e-003  9.422e-003  8.921e-003  8.980e-003  8.269e-003  1.723e-001
1.723e-001  1.723e-001  1.723e-001
 5.0e-004  1.717e-001  8.737e-003  8.876e-003  6.560e-003  9.129e-003  8.585e-003  4.364e-003  4.606e-003  3.773e-003  1.639e-001
1.620e-001  1.681e-001  1.669e-001
 1.0e-003  1.527e-001  7.313e-003  7.545e-003  4.654e-003  8.050e-003  6.927e-003  2.417e-003  2.513e-003  2.277e-003  1.444e-001
1.399e-001  1.550e-001  1.520e-001
 5.0e-003  7.585e-002  2.614e-003  2.522e-003  1.324e-003  2.700e-003  1.963e-003  4.038e-004  3.900e-004  4.921e-004  6.947e-002
6.561e-002  8.344e-002  7.937e-002
 7.0e-003  6.161e-002  1.931e-003  1.782e-003  9.528e-004  1.869e-003  1.341e-003  2.503e-004  2.414e-004  3.141e-004  5.644e-002
5.362e-002  6.786e-002  6.471e-002
    0.010  4.854e-002  1.366e-003  1.192e-003  6.575e-004  1.217e-003  8.620e-004  1.416e-004  1.377e-004  1.811e-004  4.478e-002
4.265e-002  5.319e-002  5.107e-002
    0.020  2.867e-002  6.421e-004  4.961e-004  2.975e-004  4.743e-004  3.238e-004  3.687e-005  3.807e-005  4.762e-005  2.744e-002
2.527e-002  3.088e-002  3.010e-002
    0.050  1.192e-002  1.872e-004  1.239e-004  8.676e-005  9.955e-005  6.084e-005  3.504e-006  4.326e-006  4.124e-006  1.239e-002
9.986e-003  1.274e-002  1.236e-002
    0.070  8.207e-003  1.084e-004  6.830e-005  5.169e-005  4.885e-005  2.815e-005  1.300e-006  1.725e-006  1.338e-006  8.737e-003
6.744e-003  8.794e-003  8.437e-003
    0.100  5.417e-003  5.670e-005  3.420e-005  2.855e-005  2.071e-005  1.120e-005  4.569e-007  6.316e-007  3.564e-007  5.842e-003
4.410e-003  5.835e-003  5.524e-003
    0.200  2.330e-003  1.272e-005  7.336e-006  7.780e-006  2.916e-006  1.501e-006  7.400e-008  9.632e-008  2.967e-008  2.478e-003
1.888e-003  2.558e-003  2.384e-003
    0.300  1.385e-003  4.512e-006  2.634e-006  3.293e-006  8.365e-007  4.662e-007  2.457e-008  3.217e-008  7.727e-009  1.443e-003
1.076e-003  1.546e-003  1.469e-003
    0.400  9.334e-004  2.002e-006  1.207e-006  1.706e-006  3.456e-007  2.080e-007  1.003e-008  1.378e-008  2.777e-009  9.533e-004
6.761e-004  1.060e-003  1.043e-003
    0.500  6.700e-004  1.023e-006  6.407e-007  9.946e-007  1.728e-007  1.085e-007  4.590e-009  6.645e-009  1.163e-009  6.680e-004
4.461e-004  7.745e-004  7.904e-004
    0.600  4.986e-004  5.761e-007  3.763e-007  6.281e-007  9.612e-008  6.186e-008  2.258e-009  3.457e-009  5.292e-010  4.831e-004
3.039e-004  5.871e-004  6.195e-004
    0.700  3.799e-004  3.491e-007  2.377e-007  4.205e-007  5.737e-008  3.728e-008  1.166e-009  1.898e-009  2.512e-010  3.564e-004
2.120e-004  4.558e-004  4.949e-004
    0.800  2.944e-004  2.248e-007  1.583e-007  2.942e-007  3.594e-008  2.326e-008  6.208e-010  1.084e-009  1.217e-010  2.669e-004
1.506e-004  3.600e-004  4.001e-004
    1.000  1.838e-004  1.073e-007  7.870e-008  1.584e-007  1.542e-008  9.701e-009  1.833e-010  3.819e-010  2.726e-011  1.548e-004
7.936e-005  2.331e-004  2.677e-004
    1.200  1.191e-004  5.850e-008  4.361e-008  9.356e-008  7.144e-009  4.302e-009  5.258e-011  1.426e-010  3.277e-012  9.286e-005
4.372e-005  1.565e-004  1.831e-004
    1.500  6.530e-005  2.750e-008  2.063e-008  4.772e-008  2.462e-009  1.355e-009  5.264e-012  3.256e-011  3.560e-307  4.513e-005
1.892e-005  9.034e-005  1.068e-004
    2.000  2.644e-005  1.055e-008  7.434e-009  1.911e-008  4.780e-010  2.081e-010  3.560e-307  2.170e-012  3.560e-307  1.473e-005
5.049e-006  3.952e-005  4.645e-005
    3.000  5.357e-006  2.621e-009  1.518e-009  4.764e-009  2.105e-011  3.287e-012  3.560e-307  3.560e-307  3.560e-307  1.547e-006
1.396e-007  9.293e-006  1.044e-005
    4.000  1.165e-006  8.843e-010  4.283e-010  1.649e-009  2.018e-013  3.560e-307  3.560e-307  3.560e-307  3.560e-307  1.307e-009
4.144e-010  2.286e-006  2.373e-006
    5.000  1.450e-007  3.552e-010  1.465e-010  6.859e-010  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
4.705e-012  3.295e-007  2.502e-007
    7.000  1.707e-011  7.371e-011  2.032e-011  1.668e-010  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  6.290e-015  2.537e-306
   10.000  2.339e-012  8.143e-012  5.609e-013  2.962e-011  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306

SPECTRAL PERIOD: 2
  Column 1: Acceleration (g)
  Column 2: Mean
  Column 3: Frankel (1996) USGS 2008 Truncated Mw
```

Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
Column 5: Silva et al (2002) USGS 2008 Mw
Column 6: Campbell (2003) USGS 2008 Mw
Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
Column 10: Atkinson (2008p) USGS 2014 Table Soil
Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 12: Boore-et al (2014) NGA West 2 USGS 2014
Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.804e-001	9.358e-003	9.387e-003	8.627e-003	9.424e-003	9.352e-003	7.576e-003	7.649e-003	6.925e-003	1.720e-001	1.717e-001	1.721e-001	1.721e-001
5.0e-004	1.578e-001	7.319e-003	7.679e-003	5.224e-003	8.480e-003	7.106e-003	2.593e-003	2.600e-003	2.680e-003	1.516e-001	1.455e-001	1.573e-001	1.566e-001
1.0e-003	1.288e-001	5.244e-003	5.597e-003	3.477e-003	6.592e-003	4.819e-003	1.356e-003	1.309e-003	1.594e-003	1.228e-001	1.144e-001	1.328e-001	1.314e-001
5.0e-003	5.561e-002	1.520e-003	1.449e-003	9.398e-004	1.653e-003	9.946e-004	1.991e-004	1.795e-004	2.986e-004	5.199e-002	4.887e-002	5.960e-002	5.886e-002
7.0e-003	4.474e-002	1.112e-003	1.010e-003	6.777e-004	1.113e-003	6.497e-004	1.174e-004	1.058e-004	1.801e-004	4.194e-002	3.971e-002	4.772e-002	4.749e-002
0.010	3.495e-002	7.820e-004	6.711e-004	4.694e-004	7.091e-004	3.975e-004	6.234e-005	5.667e-005	9.694e-005	3.305e-002	3.116e-002	3.707e-002	3.717e-002
0.020	2.009e-002	3.613e-004	2.770e-004	2.142e-004	2.628e-004	1.299e-004	1.402e-005	1.349e-005	2.168e-005	1.971e-002	1.755e-002	2.126e-002	2.134e-002
0.050	8.018e-003	9.939e-005	6.651e-005	6.326e-005	4.798e-005	1.805e-005	1.124e-006	1.270e-006	1.442e-006	8.309e-003	6.662e-003	8.674e-003	8.317e-003
0.070	5.493e-003	5.562e-005	3.579e-005	3.789e-005	2.189e-005	7.383e-006	4.096e-007	4.876e-007	4.255e-007	5.720e-003	4.551e-003	6.033e-003	5.613e-003
0.100	3.635e-003	2.785e-005	1.738e-005	2.105e-005	8.551e-006	2.650e-006	1.488e-007	1.798e-007	1.127e-007	3.750e-003	3.036e-003	4.069e-003	3.660e-003
0.200	1.593e-003	5.616e-006	3.470e-006	5.803e-006	1.066e-006	3.479e-007	2.223e-008	2.627e-008	1.081e-008	1.570e-003	1.329e-003	1.852e-003	1.616e-003
0.300	9.599e-004	1.849e-006	1.189e-006	2.469e-006	2.965e-007	1.057e-007	6.163e-009	7.723e-009	2.666e-009	9.143e-004	7.544e-004	1.142e-003	1.027e-003
0.400	6.484e-004	7.763e-007	5.260e-007	1.281e-006	1.173e-007	4.245e-008	2.117e-009	2.830e-009	8.689e-010	5.985e-004	4.676e-004	7.883e-004	7.384e-004
0.500	4.625e-004	3.785e-007	2.726e-007	7.468e-007	5.518e-008	1.953e-008	8.180e-010	1.178e-009	3.196e-010	4.130e-004	3.039e-004	5.748e-004	5.578e-004
0.600	3.405e-004	2.060e-007	1.569e-007	4.707e-007	2.885e-008	9.630e-009	3.359e-010	5.299e-010	1.249e-010	2.939e-004	2.036e-004	4.326e-004	4.317e-004
0.700	2.563e-004	1.226e-007	9.709e-008	3.144e-007	1.608e-008	4.979e-009	1.418e-010	2.502e-010	4.873e-011	2.138e-004	1.397e-004	3.327e-004	3.389e-004
0.800	1.961e-004	7.819e-008	6.340e-008	2.193e-007	9.317e-009	2.668e-009	5.907e-011	1.216e-010	1.729e-011	1.580e-004	9.770e-005	2.599e-004	2.686e-004
1.000	1.190e-004	3.625e-008	3.050e-008	1.173e-007	3.401e-009	8.188e-010	8.242e-012	2.912e-011	1.322e-012	8.953e-005	4.991e-005	1.642e-004	1.725e-004
1.200	7.506e-005	1.921e-008	1.649e-008	6.875e-008	1.335e-009	2.635e-010	4.413e-013	6.858e-012	3.560e-307	5.268e-005	2.668e-005	1.073e-004	1.135e-004
1.500	3.966e-005	9.057e-009	7.541e-009	3.461e-008	3.582e-010	4.932e-011	3.560e-307	3.476e-013	3.560e-307	2.511e-005	1.102e-005	5.955e-005	6.296e-005
2.000	1.519e-005	3.478e-009	2.580e-009	1.358e-008	4.578e-011	1.990e-012	3.560e-307	3.560e-307	3.560e-307	8.017e-006	2.636e-006	2.449e-005	2.561e-005
3.000	2.651e-006	7.948e-010	4.801e-010	3.353e-009	9.160e-014	3.560e-307	3.560e-307	3.560e-307	3.560e-307	6.163e-007	3.473e-008	5.020e-006	4.930e-006
4.000	4.059e-007	2.479e-010	1.246e-010	1.177e-009	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	4.566e-011	8.285e-011	8.906e-007	7.326e-007
5.000	1.266e-008	9.018e-011	3.621e-011	4.997e-010	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	4.437e-008	6.101e-009
7.000	8.946e-012	1.387e-011	2.667e-012	1.295e-010	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	1.456e-012	1.940e-013	3.560e-307	2.407e-011	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 3
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Frankel (1996) USGS 2008 Truncated Mw
Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
Column 5: Silva et al (2002) USGS 2008 Mw
Column 6: Campbell (2003) USGS 2008 Mw
Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
Column 10: Atkinson (2008p) USGS 2014 Table Soil
Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 12: Boore-et al (2014) NGA West 2 USGS 2014
Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.750e-001	8.550e-003	9.285e-003	6.886e-003	9.333e-003	8.677e-003	4.057e-003	4.542e-003	4.951e-003	1.679e-001	1.665e-001	1.695e-001	1.696e-001
5.0e-004	1.239e-001	4.233e-003	6.526e-003	3.135e-003	6.546e-003	4.267e-003	9.798e-004	1.070e-003	1.826e-003	1.170e-001	1.122e-001	1.271e-001	1.261e-001

 1.0e-003 9.035e-002 2.540e-003 4.279e-003 1.923e-003 4.113e-003 2.385e-003 4.752e-004 5.041e-004 1.089e-003 8.435e-002
8.093e-002 9.527e-002 9.301e-002
 5.0e-003 3.554e-002 6.241e-004 9.349e-004 4.759e-004 7.611e-004 3.879e-004 5.031e-005 5.120e-005 1.760e-004 3.316e-002
3.327e-002 3.766e-002 3.657e-002
 7.0e-003 2.834e-002 4.459e-004 6.332e-004 3.394e-004 4.928e-004 2.397e-004 2.672e-005 2.734e-005 1.004e-004 2.671e-002
2.659e-002 2.999e-002 2.910e-002
    0.010 2.176e-002 3.040e-004 4.066e-004 2.322e-004 2.983e-004 1.353e-004 1.259e-005 1.306e-005 5.057e-005 2.082e-002
2.030e-002 2.308e-002 2.223e-002
    0.020 1.185e-002 1.297e-004 1.537e-004 1.031e-004 9.457e-005 3.507e-005 2.252e-006 2.487e-006 9.870e-006 1.176e-002
1.080e-002 1.280e-002 1.182e-002
    0.050 4.477e-003 3.071e-005 3.129e-005 2.920e-005 1.234e-005 3.261e-006 1.536e-007 1.976e-007 5.807e-007 4.493e-003
4.088e-003 5.090e-003 4.199e-003
    0.070 3.049e-003 1.609e-005 1.566e-005 1.722e-005 4.898e-006 1.200e-006 5.537e-008 7.587e-008 1.781e-007 3.005e-003
2.825e-003 3.545e-003 2.804e-003
    0.100 2.021e-003 7.462e-006 7.007e-006 9.418e-006 1.687e-006 4.145e-007 1.896e-008 2.752e-008 5.099e-008 1.937e-003
1.894e-003 2.396e-003 1.849e-003
    0.200 9.054e-004 1.280e-006 1.189e-006 2.520e-006 1.883e-007 5.032e-008 1.963e-009 3.339e-009 4.926e-009 8.202e-004
8.105e-004 1.101e-003 8.887e-004
    0.300 5.382e-004 3.789e-007 3.727e-007 1.054e-006 4.834e-008 1.168e-008 3.572e-010 7.273e-010 1.136e-009 4.678e-004
4.394e-004 6.737e-004 5.713e-004
    0.400 3.492e-004 1.483e-007 1.569e-007 5.390e-007 1.694e-008 3.274e-009 7.861e-011 2.005e-010 3.409e-010 2.912e-004
2.594e-004 4.530e-004 3.929e-004
    0.500 2.366e-004 6.995e-008 7.795e-008 3.105e-007 6.801e-009 9.989e-010 1.759e-011 6.160e-011 1.161e-010 1.891e-004
1.608e-004 3.188e-004 2.775e-004
    0.600 1.649e-004 3.683e-008 4.321e-008 1.942e-007 2.947e-009 3.114e-010 3.507e-012 2.001e-011 4.127e-011 1.264e-004
1.032e-004 2.306e-004 1.994e-004
    0.700 1.175e-004 2.110e-008 2.590e-008 1.288e-007 1.344e-009 9.376e-011 3.234e-013 6.373e-012 1.496e-011 8.629e-005
6.802e-005 1.702e-004 1.453e-004
    0.800 8.518e-005 1.305e-008 1.649e-008 8.908e-008 6.329e-010 2.639e-011 3.560e-307 1.710e-012 5.714e-012 6.003e-005
4.583e-005 1.276e-004 1.072e-004
    1.000 4.680e-005 6.065e-009 7.541e-009 4.677e-008 1.488e-010 1.072e-012 3.560e-307 3.560e-307 6.608e-013 3.041e-005
2.186e-005 7.451e-005 6.042e-005
    1.200 2.695e-005 3.370e-009 3.858e-009 2.685e-008 3.861e-011 3.560e-307 3.560e-307 3.560e-307 3.560e-307 1.614e-005
1.096e-005 4.529e-005 3.540e-005
    1.500 1.253e-005 1.599e-009 1.617e-009 1.311e-008 4.353e-012 3.560e-307 3.560e-307 3.560e-307 3.560e-307 6.548e-006
4.088e-006 2.276e-005 1.673e-005
    2.000 3.795e-006 5.707e-010 4.801e-010 4.953e-009 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 1.378e-006
7.002e-007 7.970e-006 5.130e-006
    3.000 3.082e-007 1.123e-010 6.654e-011 1.186e-009 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 8.041e-010
1.926e-009 9.450e-007 2.847e-007
    4.000 7.736e-009 2.704e-011 1.061e-011 4.095e-010 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 2.537e-306
2.537e-306 3.083e-008 2.537e-306
    5.000 1.098e-011 6.264e-012 1.173e-012 1.742e-010 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 2.537e-306
2.537e-306 1.595e-015 2.537e-306
    7.000 2.620e-012 3.560e-307 3.560e-307 4.367e-011 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 2.537e-306
2.537e-306 2.537e-306 2.537e-306
   10.000 4.520e-013 3.560e-307 3.560e-307 7.534e-012 3.560e-307 3.560e-307 3.560e-307 3.560e-307 3.560e-307 2.537e-306
2.537e-306 2.537e-306 2.537e-306

SPECTRAL PERIOD: 4
  Column 1: Acceleration (g)
  Column 2: Mean
  Column 3: Frankel (1996) USGS 2008 Truncated Mw
  Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
  Column 5: Silva et al (2002) USGS 2008 Mw
  Column 6: Campbell (2003) USGS 2008 Mw
  Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
  Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
  Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
  Column 10: Atkinson (2008p) USGS 2014 Table Soil
  Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
  Column 12: Boore-et al (2014) NGA West 2 USGS 2014
  Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

       1   2   3   4   5   6   7   8   9   10   11
12   13   14
 1.0e-004 1.644e-001 6.870e-003 9.124e-003 5.355e-003 8.934e-003 9.240e-003 2.441e-003 2.624e-003 3.584e-003 1.572e-001
1.558e-001 1.629e-001 1.592e-001
 5.0e-004 9.632e-002 2.490e-003 5.597e-003 2.108e-003 4.555e-003 6.316e-003 5.276e-004 5.469e-004 1.228e-003 8.982e-002
8.861e-002 1.034e-001 9.252e-002
 1.0e-003 6.699e-002 1.429e-003 3.420e-003 1.254e-003 2.502e-003 4.138e-003 2.396e-004 2.413e-004 6.822e-004 6.229e-002
6.234e-002 7.307e-002 6.377e-002
 5.0e-003 2.548e-002 3.387e-004 6.711e-004 2.999e-004 3.937e-004 9.597e-004 1.945e-005 1.811e-005 8.053e-005 2.462e-002
2.489e-002 2.739e-002 2.377e-002
 7.0e-003 1.993e-002 2.388e-004 4.442e-004 2.124e-004 2.438e-004 6.604e-004 9.653e-006 8.893e-006 4.249e-005 1.964e-002
1.943e-002 2.145e-002 1.835e-002
    0.010 1.487e-002 1.597e-004 2.770e-004 1.442e-004 1.386e-004 4.299e-004 4.242e-006 3.889e-006 1.969e-005 1.501e-002
1.443e-002 1.609e-002 1.342e-002
    0.020 7.645e-003 6.447e-005 9.729e-005 6.288e-005 3.694e-005 1.631e-004 6.718e-007 6.356e-007 3.274e-006 8.003e-003
7.394e-003 8.474e-003 6.522e-003
    0.050 2.750e-003 1.374e-005 1.738e-005 1.739e-005 3.594e-006 2.964e-005 4.070e-008 4.747e-008 1.724e-007 2.797e-003
2.738e-003 3.227e-003 2.205e-003
    0.070 1.858e-003 6.861e-006 8.233e-006 1.017e-005 1.309e-006 1.345e-005 1.392e-008 1.817e-008 5.471e-008 1.832e-003
1.863e-003 2.208e-003 1.511e-003
    0.100 1.229e-003 3.015e-006 3.470e-006 5.516e-006 4.277e-007 5.235e-006 4.525e-009 6.446e-009 1.676e-008 1.177e-003
1.220e-003 1.464e-003 1.049e-003
    0.200 5.208e-004 4.557e-007 5.260e-007 1.455e-006 4.433e-008 6.619e-007 3.141e-010 5.538e-010 1.676e-009 4.824e-004
4.700e-004 6.207e-004 5.091e-004

0.300	2.754e-004	1.257e-007	1.569e-007	6.029e-007	9.849e-009	1.914e-007	3.690e-011	8.482e-011	3.551e-010	2.496e-004	2.276e-004	3.343e-004	2.895e-004
0.400	1.571e-004	4.720e-008	6.340e-008	3.061e-007	2.760e-009	7.778e-008	4.292e-012	1.594e-011	9.772e-011	1.389e-004	1.211e-004	1.955e-004	1.725e-004
0.500	9.390e-005	2.085e-008	3.050e-008	1.757e-007	8.661e-010	3.771e-008	1.618e-013	2.677e-012	3.032e-011	8.086e-005	6.844e-005	1.199e-004	1.063e-004
0.600	5.820e-005	1.063e-008	1.649e-008	1.096e-007	2.865e-010	2.029e-008	3.560e-307	2.399e-013	1.013e-011	4.874e-005	4.038e-005	7.614e-005	6.747e-005
0.700	3.712e-005	6.142e-009	9.646e-009	7.231e-008	9.586e-011	1.161e-008	3.560e-307	3.560e-307	3.402e-012	3.025e-005	2.461e-005	4.966e-005	4.394e-005
0.800	2.424e-005	3.937e-009	5.969e-009	4.973e-008	3.327e-011	6.881e-009	3.560e-307	3.560e-307	9.620e-013	1.920e-005	1.540e-005	3.313e-005	2.922e-005
1.000	1.088e-005	1.927e-009	2.580e-009	2.573e-008	3.765e-012	2.610e-009	3.560e-307	3.560e-307	3.560e-307	8.082e-006	6.375e-006	1.555e-005	1.352e-005
1.200	5.074e-006	1.044e-009	1.243e-009	1.453e-008	4.369e-014	1.059e-009	3.560e-307	3.560e-307	3.560e-307	3.457e-006	2.711e-006	7.645e-006	6.479e-006
1.500	1.594e-006	4.715e-010	4.801e-010	6.926e-009	3.560e-307	2.925e-010	3.560e-307	3.560e-307	3.560e-307	8.588e-007	6.911e-007	2.691e-006	2.135e-006
2.000	1.475e-007	1.570e-010	1.246e-010	2.548e-009	3.560e-307	3.626e-011	3.560e-307	3.560e-307	3.560e-307	1.031e-008	3.859e-008	3.620e-007	1.783e-007
3.000	4.280e-011	2.273e-011	1.061e-011	5.972e-010	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	1.692e-011	2.537e-306
4.000	1.252e-011	3.069e-012	4.433e-013	2.047e-010	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
5.000	5.209e-012	3.560e-307	3.560e-307	8.682e-011	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
7.000	1.292e-012	3.560e-307	3.560e-307	2.153e-011	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	1.993e-013	3.560e-307	3.560e-307	3.322e-012	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

SPECTRAL PERIOD: 5

- Column 1: Acceleration (g)
- Column 2: Mean
- Column 3: Frankel (1996) USGS 2008 Truncated Mw
- Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
- Column 5: Silva et al (2002) USGS 2008 Mw
- Column 6: Campbell (2003) USGS 2008 Mw
- Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
- Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
- Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
- Column 10: Atkinson (2008p) USGS 2014 Table Soil
- Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
- Column 12: Boore-et al (2014) NGA West 2 USGS 2014
- Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
- Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	1.470e-001	6.210e-003	8.920e-003	4.239e-003	8.625e-003	9.101e-003	1.594e-003	1.654e-003	2.735e-003	1.405e-001	1.413e-001	1.482e-001	1.383e-001
5.0e-004	7.442e-002	2.090e-003	4.863e-003	1.542e-003	3.820e-003	5.610e-003	3.193e-004	3.188e-004	8.748e-004	7.063e-002	7.151e-002	8.009e-002	6.636e-002
1.0e-003	5.102e-002	1.187e-003	2.827e-003	9.039e-004	2.005e-003	3.498e-003	1.370e-004	1.314e-004	4.506e-004	4.882e-002	5.009e-002	5.499e-002	4.498e-002
5.0e-003	1.864e-002	2.694e-004	5.121e-004	2.121e-004	2.880e-004	7.513e-004	9.119e-006	7.600e-006	4.185e-005	1.938e-002	1.892e-002	1.978e-002	1.555e-002
7.0e-003	1.420e-002	1.864e-004	3.321e-004	1.495e-004	1.726e-004	5.072e-004	4.339e-006	3.511e-006	2.093e-005	1.521e-002	1.438e-002	1.512e-002	1.148e-002
0.010	1.031e-002	1.216e-004	2.018e-004	1.008e-004	9.388e-005	3.217e-004	1.828e-006	1.444e-006	9.153e-006	1.137e-002	1.041e-002	1.107e-002	8.001e-003
0.020	5.073e-003	4.610e-005	6.651e-005	4.344e-005	2.233e-005	1.135e-004	2.667e-007	2.183e-007	1.377e-006	5.759e-003	5.148e-003	5.644e-003	3.614e-003
0.050	1.777e-003	8.743e-006	1.067e-005	1.183e-005	1.853e-006	1.774e-005	1.397e-008	1.584e-008	7.231e-008	1.915e-003	1.824e-003	2.076e-003	1.274e-003
0.070	1.202e-003	4.147e-006	4.838e-006	6.884e-006	6.514e-007	7.543e-006	4.673e-009	6.028e-009	2.434e-008	1.264e-003	1.214e-003	1.404e-003	9.170e-004
0.100	7.866e-004	1.717e-006	1.947e-006	3.715e-006	2.113e-007	2.763e-006	1.373e-009	1.905e-009	7.915e-009	8.193e-004	7.645e-004	9.138e-004	6.449e-004
0.200	2.908e-004	2.270e-007	2.726e-007	9.720e-007	1.993e-008	3.335e-007	6.411e-011	1.129e-010	7.784e-010	3.122e-004	2.496e-004	3.404e-004	2.606e-004
0.300	1.310e-004	5.923e-008	7.795e-008	4.003e-007	3.744e-009	9.552e-008	4.061e-012	1.130e-011	1.550e-010	1.443e-004	1.031e-004	1.578e-004	1.184e-004
0.400	6.466e-005	2.085e-008	3.050e-008	2.027e-007	8.661e-010	3.771e-008	3.560e-307	8.106e-013	3.967e-011	7.223e-005	4.775e-005	8.049e-005	5.810e-005
0.500	3.400e-005	9.160e-009	1.433e-008	1.164e-007	2.179e-010	1.758e-008	3.560e-307	3.560e-307	1.152e-011	3.828e-005	2.379e-005	4.366e-005	3.023e-005
0.600	1.873e-005	4.856e-009	7.541e-009	7.236e-008	5.583e-011	8.898e-009	3.560e-307	3.560e-307	3.273e-012	2.120e-005	1.249e-005	2.481e-005	1.641e-005
0.700	1.067e-005	2.966e-009	4.287e-009	4.755e-008	1.567e-011	4.735e-009	3.560e-307	3.560e-307	7.526e-013	1.211e-005	6.798e-006	1.461e-005	9.163e-006
0.800	6.206e-006	1.927e-009	2.580e-009	3.252e-008	3.765e-012	2.610e-009	3.560e-307	3.560e-307	7.095e-014	7.040e-006	3.769e-006	8.815e-006	5.187e-006
1.000	2.118e-006	9.053e-010	1.049e-009	1.660e-008	3.560e-307	8.509e-010	3.560e-307	3.560e-307	3.560e-307	2.392e-006	1.141e-006	3.311e-006	1.622e-006
1.200	6.556e-007	4.715e-010	4.801e-010	9.257e-009	3.560e-307	2.925e-010	3.560e-307	3.560e-307	3.560e-307	7.178e-007	3.039e-007	1.199e-006	3.985e-007
1.500	6.757e-008	2.035e-010	1.724e-010	4.306e-009	3.560e-307	6.078e-011	3.560e-307	3.560e-307	3.560e-307	4.072e-008	2.918e-008	1.897e-007	9.510e-009

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    2.000  4.695e-010  5.857e-011  3.621e-011  1.553e-009  3.560e-307  3.362e-012  3.560e-307  3.560e-307  3.560e-307  2.537e-306
9.455e-011  1.376e-009  2.537e-306
    3.000  2.205e-011  5.069e-012  1.173e-012  3.598e-010  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
    4.000  7.335e-012  3.560e-307  3.560e-307  1.223e-010  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
    5.000  3.161e-012  3.560e-307  3.560e-307  5.268e-011  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
    7.000  7.602e-013  3.560e-307  3.560e-307  1.267e-011  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
   10.000  1.022e-013  3.560e-307  3.560e-307  1.703e-012  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306

SPECTRAL PERIOD: 7.5
  Column 1: Acceleration (g)
  Column 2: Mean
  Column 3: Frankel (1996) USGS 2008 Truncated Mw
  Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
  Column 5: Silva et al (2002) USGS 2008 Mw
  Column 6: Campbell (2003) USGS 2008 Mw
  Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
  Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
  Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
  Column 10: Atkinson (2008p) USGS 2014 Table Soil
  Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
  Column 12: Boore-et al (2014) NGA West 2 USGS 2014
  Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

        1           2           3           4           5           6           7           8           9          10          11
12          13          14
 1.0e-004  1.002e-001  3.811e-003  7.371e-003  2.663e-003  6.548e-003  7.897e-003  7.405e-004  7.599e-004  1.604e-003  1.058e-001
9.917e-002  9.806e-002  8.319e-002
 5.0e-004  4.421e-002  1.075e-003  2.544e-003  8.213e-004  1.776e-003  3.185e-003  1.169e-004  1.112e-004  3.954e-004  4.832e-002
4.500e-002  4.365e-002  3.521e-002
 1.0e-003  3.035e-002  5.862e-004  1.280e-003  4.534e-004  8.176e-004  1.721e-003  4.101e-005  3.682e-005  1.616e-004  3.409e-002
3.120e-002  3.014e-002  2.364e-002
 5.0e-003  9.465e-003  1.046e-004  1.695e-004  8.806e-005  7.544e-005  2.739e-004  1.347e-006  1.060e-006  6.815e-006  1.278e-002
9.388e-003  9.448e-003  5.923e-003
 7.0e-003  6.842e-003  6.595e-005  9.985e-005  5.880e-005  3.821e-005  1.671e-004  5.348e-007  4.237e-007  2.761e-006  9.571e-003
6.723e-003  6.855e-003  4.029e-003
    0.010  4.701e-003  3.824e-005  5.389e-005  3.723e-005  1.684e-005  9.255e-005  1.876e-007  1.566e-007  9.621e-007  6.728e-003
4.581e-003  4.753e-003  2.639e-003
    0.020  2.098e-003  1.086e-005  1.348e-005  1.391e-005  2.542e-006  2.273e-005  1.977e-008  2.143e-008  1.023e-007  2.958e-003
1.997e-003  2.177e-003  1.233e-003
    0.050  6.556e-004  1.254e-006  1.419e-006  2.999e-006  1.446e-007  1.947e-006  8.794e-010  1.255e-009  5.452e-009  8.638e-004
5.538e-004  7.044e-004  4.976e-004
    0.070  4.000e-004  4.779e-007  5.506e-007  1.578e-006  4.682e-008  6.951e-007  2.119e-010  3.347e-010  1.807e-009  5.357e-004
3.082e-004  4.346e-004  3.205e-004
    0.100  2.153e-004  1.554e-007  1.912e-007  7.578e-007  1.274e-008  2.332e-007  3.298e-011  6.222e-011  5.012e-010  3.026e-004
1.462e-004  2.370e-004  1.749e-004
    0.200  4.180e-005  1.346e-008  2.053e-008  1.517e-007  4.322e-010  2.534e-008  3.560e-307  1.043e-013  2.114e-011  6.807e-005
2.033e-005  4.751e-005  3.124e-005
    0.300  1.108e-005  3.329e-009  4.906e-009  5.259e-008  2.155e-011  5.520e-009  3.560e-307  3.560e-307  1.132e-012  2.004e-005
4.025e-006  1.292e-005  7.308e-006
    0.400  3.360e-006  1.301e-009  1.617e-009  2.295e-008  5.299e-013  1.477e-009  3.560e-307  3.560e-307  3.560e-307  6.743e-006
8.559e-007  4.021e-006  1.811e-006
    0.500  1.025e-006  5.966e-010  6.354e-010  1.143e-008  3.560e-307  4.350e-010  3.560e-307  3.560e-307  3.560e-307  2.344e-006
1.633e-007  1.239e-006  3.488e-007
    0.600  2.828e-007  3.054e-010  2.838e-010  6.219e-009  3.560e-307  1.329e-010  3.560e-307  3.560e-307  3.560e-307  7.476e-007
2.870e-008  3.214e-007  3.170e-008
    0.700  6.043e-008  1.675e-010  1.350e-010  3.632e-009  3.560e-307  4.126e-011  3.560e-307  3.560e-307  3.560e-307  1.734e-007
4.317e-009  6.259e-008  4.326e-010
    0.800  7.095e-009  9.532e-011  6.654e-011  2.263e-009  3.560e-307  1.221e-011  3.560e-307  3.560e-307  3.560e-307  1.875e-008
1.091e-009  7.936e-009  2.537e-306
    1.000  1.016e-010  3.230e-011  1.704e-011  1.020e-009  3.560e-307  3.250e-013  3.560e-307  3.560e-307  3.560e-307  2.537e-306
1.446e-010  2.537e-306  2.537e-306
    1.200  3.351e-011  1.097e-011  3.880e-012  5.291e-010  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.395e-012  2.537e-306  2.537e-306
    1.500  1.408e-011  1.840e-012  1.367e-013  2.325e-010  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
    2.000  4.708e-012  3.560e-307  3.560e-307  7.847e-011  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
    3.000  8.987e-013  3.560e-307  3.560e-307  1.498e-011  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
    4.000  2.024e-013  3.560e-307  3.560e-307  3.373e-012  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
    5.000  4.121e-014  3.560e-307  3.560e-307  6.869e-013  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
    7.000  2.893e-306  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306
   10.000  2.893e-306  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  3.560e-307  2.537e-306
2.537e-306  2.537e-306  2.537e-306

SPECTRAL PERIOD: 10
  Column 1: Acceleration (g)
  Column 2: Mean
  Column 3: Frankel (1996) USGS 2008 Truncated Mw
  Column 4: Toro (1999) Midcontinent - USGS 2008 Mw
  Column 5: Silva et al (2002) USGS 2008 Mw
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Column 6: Campbell (2003) USGS 2008 Mw
Column 7: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Column 8: Atkinson-Boore (2006p) USGS 2014 Table Soil
Column 9: Pezeshk et al (2011) USGS 2014 Table Soil
Column 10: Atkinson (2008p) USGS 2014 Table Soil
Column 11: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 12: Boore-et al (2014) NGA West 2 USGS 2014
Column 13: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 14: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0e-004	7.088e-002	2.490e-003	5.597e-003	1.810e-003	4.555e-003	6.316e-003	4.085e-004	4.119e-004	1.050e-003	8.116e-002	6.964e-002	6.936e-002	5.276e-002
5.0e-004	3.095e-002	6.520e-004	1.449e-003	5.036e-004	9.393e-004	1.924e-003	4.976e-005	4.513e-005	1.913e-004	3.744e-002	3.049e-002	3.081e-002	2.240e-002
1.0e-003	2.057e-002	3.387e-004	6.711e-004	2.647e-004	3.937e-004	9.597e-004	1.439e-005	1.224e-005	6.350e-005	2.687e-002	1.984e-002	2.054e-002	1.381e-002
5.0e-003	5.373e-003	4.610e-005	6.651e-005	4.344e-005	2.233e-005	1.135e-004	2.667e-007	2.183e-007	1.377e-006	9.094e-003	4.667e-003	5.002e-003	2.601e-003
7.0e-003	3.739e-003	2.650e-005	3.579e-005	2.769e-005	9.660e-006	6.183e-005	9.471e-008	8.368e-008	4.829e-007	6.487e-003	3.170e-003	3.457e-003	1.773e-003
0.010	2.476e-003	1.374e-005	1.738e-005	1.660e-005	3.594e-006	2.964e-005	2.930e-008	2.997e-008	1.510e-007	4.299e-003	2.045e-003	2.302e-003	1.225e-003
0.020	1.050e-003	3.015e-006	3.470e-006	5.494e-006	4.277e-007	5.235e-006	3.013e-009	3.987e-009	1.596e-008	1.696e-003	8.103e-004	1.049e-003	6.380e-004
0.050	2.700e-004	2.270e-007	2.726e-007	9.720e-007	1.993e-008	3.335e-007	6.411e-011	1.129e-010	7.784e-010	4.201e-004	1.557e-004	3.201e-004	1.834e-004
0.070	1.400e-004	7.514e-008	9.709e-008	4.684e-007	5.119e-009	1.187e-007	7.393e-012	1.785e-011	2.082e-010	2.283e-004	6.603e-005	1.754e-004	8.985e-005
0.100	6.022e-005	2.085e-008	3.050e-008	2.027e-007	8.661e-010	3.771e-008	3.560e-307	8.106e-013	3.967e-011	1.060e-004	2.145e-005	7.892e-005	3.446e-005
0.200	6.531e-006	1.927e-009	2.580e-009	3.252e-008	3.765e-012	2.610e-009	3.560e-307	3.560e-307	7.095e-014	1.397e-005	8.939e-007	8.998e-006	2.247e-006
0.300	9.741e-007	4.715e-010	4.801e-010	9.257e-009	3.560e-307	2.925e-010	3.560e-307	3.560e-307	3.560e-307	2.516e-006	3.833e-008	1.263e-006	7.667e-008
0.400	1.213e-007	1.570e-010	1.246e-010	3.434e-009	3.560e-307	3.626e-011	3.560e-307	3.560e-307	3.560e-307	3.901e-007	2.645e-009	9.162e-008	1.153e-011
0.500	5.921e-009	5.857e-011	3.621e-011	1.553e-009	3.560e-307	3.362e-012	3.560e-307	3.560e-307	3.560e-307	2.170e-008	5.295e-010	1.044e-009	2.537e-306
0.600	7.285e-011	2.273e-011	1.061e-011	8.084e-010	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	1.154e-011	7.488e-011	2.537e-306	2.537e-306
0.700	2.867e-011	8.617e-012	2.667e-012	4.635e-010	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
0.800	1.727e-011	3.069e-012	4.433e-013	2.838e-010	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
1.000	7.335e-012	3.560e-307	3.560e-307	1.223e-010	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
1.200	3.701e-012	3.560e-307	3.560e-307	6.168e-011	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
1.500	1.510e-012	3.560e-307	3.560e-307	2.516e-011	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
2.000	3.924e-013	3.560e-307	3.560e-307	6.539e-012	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
3.000	2.442e-014	3.560e-307	3.560e-307	4.070e-013	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
4.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
5.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
7.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306
10.000	2.893e-306	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	3.560e-307	2.537e-306	2.537e-306	2.537e-306	2.537e-306

Probabilistic Spectra results for EZ-FRISK 8.07 Build 044

ANNUAL FREQUENCY OF EXCEEDANCE: 4.041e-004
RETURN PERIOD: 2474.9
PROBABILITY OF EXCEEDENCE: 2.0% IN 50.0 YEARS
  Column 1: Spectral Period
  Column 2: Acceleration (g) for: Mean
  Column 3: Acceleration (g) for: Frankel (1996) USGS 2008 Truncated Mw
  Column 4: Acceleration (g) for: Toro (1999) Midcontinent - USGS 2008 Mw
  Column 5: Acceleration (g) for: Silva et al (2002) USGS 2008 Mw
  Column 6: Acceleration (g) for: Campbell (2003) USGS 2008 Mw
  Column 7: Acceleration (g) for: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
  Column 8: Acceleration (g) for: Atkinson-Boore (2006p) USGS 2014 Table Soil
  Column 9: Acceleration (g) for: Pezeshk et al (2011) USGS 2014 Table Soil
  Column 10: Acceleration (g) for: Atkinson (2008p) USGS 2014 Table Soil
  Column 11: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
  Column 12: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
  Column 13: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 14: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6	7	8	9	10	11	12	13	14
PGA	5.634e-001	9.661e-002	7.727e-002	6.586e-002	8.806e-002	4.937e-002	2.618e-002	3.369e-002	6.803e-002	6.330e-001	5.571e-001	4.635e-001	5.866e-001
0.02	5.711e-001	1.149e-001	1.006e-001	8.535e-002	1.275e-001	6.794e-002	4.649e-002	3.420e-002	9.540e-002	6.292e-001	5.575e-001	4.837e-001	5.910e-001
0.03	5.760e-001	1.272e-001	1.165e-001	9.970e-002	1.654e-001	8.182e-002	4.637e-002	3.041e-002	8.735e-002	6.010e-001	5.795e-001	5.028e-001	5.966e-001
0.05	6.315e-001	1.450e-001	1.407e-001	1.198e-001	2.081e-001	1.041e-001	3.672e-002	2.189e-002	5.914e-002	6.183e-001	6.845e-001	5.629e-001	6.369e-001
0.075	7.480e-001	1.614e-001	1.642e-001	1.391e-001	2.157e-001	1.017e-001	4.927e-002	4.411e-002	7.876e-002	7.126e-001	8.510e-001	6.636e-001	7.484e-001
0.1	8.640e-001	1.746e-001	1.839e-001	1.551e-001	2.133e-001	1.143e-001	5.960e-002	7.417e-002	9.707e-002	8.450e-001	9.558e-001	7.839e-001	8.622e-001
0.15	1.055e+000	1.958e-001	1.777e-001	1.274e-001	1.971e-001	1.020e-001	5.575e-002	7.238e-002	8.510e-002	1.169e+000	1.106e+000	8.637e-001	1.039e+000
0.2	1.204e+000	2.111e-001	1.740e-001	1.114e-001	1.800e-001	1.006e-001	5.343e-002	7.134e-002	7.801e-002	1.361e+000	1.215e+000	9.511e-001	1.217e+000
0.25	1.284e+000	1.875e-001	1.466e-001	9.235e-002	1.527e-001	1.197e-001	4.484e-002	6.142e-002	6.094e-002	1.465e+000	1.230e+000	1.042e+000	1.355e+000
0.3	1.347e+000	1.699e-001	1.287e-001	7.900e-002	1.347e-001	1.387e-001	3.885e-002	5.463e-002	5.016e-002	1.540e+000	1.234e+000	1.148e+000	1.440e+000
0.4	1.371e+000	1.332e-001	9.927e-002	6.049e-002	1.000e-001	7.773e-002	3.016e-002	3.801e-002	3.294e-002	1.589e+000	1.151e+000	1.219e+000	1.504e+000
0.5	1.328e+000	1.119e-001	8.059e-002	4.938e-002	7.840e-002	4.953e-002	2.518e-002	2.921e-002	2.488e-002	1.459e+000	1.116e+000	1.222e+000	1.515e+000
0.75	1.129e+000	7.508e-002	5.585e-002	3.130e-002	5.385e-002	3.228e-002	1.477e-002	1.615e-002	1.446e-002	1.094e+000	8.981e-001	1.189e+000	1.348e+000
1	9.378e-001	5.688e-002	4.290e-002	2.335e-002	3.726e-002	2.301e-002	1.028e-002	1.065e-002	1.005e-002	8.866e-001	7.598e-001	9.882e-001	1.148e+000
1.5	6.759e-001	2.822e-002	2.290e-002	1.530e-002	2.197e-002	1.710e-002	4.997e-003	4.849e-003	5.796e-003	6.569e-001	5.241e-001	7.494e-001	7.951e-001
2	5.419e-001	1.809e-002	1.488e-002	1.142e-002	1.481e-002	9.881e-003	2.761e-003	2.591e-003	3.739e-003	5.059e-001	4.314e-001	6.246e-001	6.258e-001
3	3.630e-001	7.672e-003	1.004e-002	5.885e-003	8.060e-003	4.822e-003	1.123e-003	1.168e-003	2.400e-003	3.279e-001	3.140e-001	4.301e-001	3.915e-001
4	2.351e-001	4.105e-003	7.519e-003	3.575e-003	4.889e-003	1.045e-002	6.320e-004	6.461e-004	1.484e-003	2.230e-001	2.176e-001	2.650e-001	2.361e-001
5	1.591e-001	3.220e-003	6.011e-003	2.445e-003	3.776e-003	8.365e-003	3.950e-004	3.966e-004	1.077e-003	1.662e-001	1.484e-001	1.773e-001	1.430e-001
7.5	6.952e-002	1.415e-003	2.504e-003	1.120e-003	1.610e-003	3.558e-003	1.696e-004	1.697e-004	4.878e-004	8.348e-002	5.992e-002	7.306e-002	5.863e-002
10	3.809e-002	8.297e-004	1.424e-003	6.339e-004	9.796e-004	1.920e-003	1.008e-004	1.014e-004	2.466e-004	5.109e-002	2.944e-002	4.177e-002	2.798e-002

Deaggregation results for EZ-FRISK 8.07 Build 044

DEAGGREGATION: Magnitude
All magnitudes in Moment Magnitude scale.
Spectral Period: PGA
Amplitude: 0.5
Annual Frequency of Exceedance: 5.478e-004
Mode Magnitude: 7.15
Mode Rate (by magnitude): 8.466e-005
Mean Magnitude: 6.91

Magnitude	Probability Density
5.05	6.840e-003
5.15	4.790e-003
5.25	4.820e-003
5.35	4.897e-003
5.45	5.038e-003
5.55	4.943e-003
5.65	4.572e-003
5.75	4.235e-003
5.85	3.927e-003
5.95	3.652e-003
6.05	8.000e-003
6.15	5.030e-003
6.25	1.907e-002
6.35	5.992e-003
6.45	1.355e-002
6.55	5.754e-002
6.65	5.441e-002
6.75	6.959e-002
6.85	8.102e-002
6.95	1.390e-001
7.05	1.431e-001
7.15	1.545e-001
7.25	1.042e-001
7.35	6.082e-002
7.45	2.647e-002
7.55	7.201e-003
7.65	7.581e-004
7.75	6.519e-004
7.85	6.658e-004
7.95	6.894e-004
8.05	2.087e-292
8.15	2.087e-292
8.25	2.087e-292
8.35	2.087e-292
8.45	2.087e-292
8.55	2.087e-292
8.65	2.087e-292
8.75	2.087e-292
8.85	2.087e-292
8.95	2.087e-292

Integral : 1.000e+000

DEAGGREGATION: Distance
Spectral Period: PGA
Amplitude: 0.5
Annual Frequency of Exceedance: 5.478e-004
Mode Distance: 1.25
Mode Rate (by distance): 3.619e-004
Mean Distance: 5.53

Distance	Probability Density
1.25	6.606e-001
3.75	1.680e-002
6.25	4.661e-002
8.75	2.483e-002
11.25	4.159e-002
13.75	1.017e-001
16.25	2.758e-002
18.75	2.860e-002
21.25	2.284e-002
23.75	1.026e-002
26.25	3.295e-003
28.75	2.089e-003
31.25	1.867e-003
33.75	3.048e-003
36.25	2.971e-003
38.75	5.357e-004
41.25	1.050e-003
43.75	2.450e-004
46.25	7.183e-004
48.75	1.908e-004
51.25	6.452e-005
53.75	5.419e-004
56.25	3.668e-004
58.75	3.693e-004
61.25	1.520e-008

63.75	1.144e-009
66.25	2.617e-004
68.75	2.812e-010
71.25	2.891e-010
73.75	1.922e-004
76.25	5.484e-011
78.75	2.036e-292
81.25	2.036e-292
83.75	1.541e-004
86.25	2.036e-292
88.75	2.036e-292
91.25	2.036e-292
93.75	1.409e-004
96.25	2.036e-292
98.75	2.036e-292
101.25	4.956e-004

Integral : 1.000e+000

DEAGGREGATION: Epsilon

Spectral Period:	PGA
Amplitude:	0.5
Annual Frequency of Exceedance:	5.478e-004
Mode Epsilon:	-0.10
Mode Rate (by epsilon):	1.726e-004
Mean Epsilon:	0.48

Epsilon	Probability Density
-2.1	1.028e-004
-1.9	4.181e-005
-1.7	5.356e-005
-1.5	7.360e-005
-1.3	7.853e-005
-1.1	1.166e-004
-0.9	1.838e-004
-0.7	2.086e-004
-0.5	2.725e-004
-0.3	5.213e-002
-0.1	3.151e-001
0.1	3.471e-002
0.3	1.802e-001
0.5	1.197e-001
0.7	3.624e-002
0.9	3.606e-002
1.1	5.733e-002
1.3	3.055e-002
1.5	3.412e-002
1.7	3.411e-002
1.9	2.801e-002
2.1	1.549e-002
2.3	1.275e-002
2.5	7.607e-003
2.7	3.836e-003
2.9	9.597e-004
3.1	2.609e-292
3.3	2.609e-292
3.5	2.609e-292
3.7	2.609e-292
3.9	2.609e-292
4.1	2.609e-292

Integral : 1.000e+000

DEAGGREGATION: Magnitude - Distance

All magnitudes in Moment Magnitude scale.

Spectral Period:	PGA
Amplitude:	0.5
Annual Frequency of Exceedance:	5.478e-004
Mode Magnitude:	7.15
Mode Distance:	1.25
Mode Rate (by distance and magnitude):	6.536e-005
Mean Magnitude:	6.91
Mean Distance:	5.53

Magnitude	Distance	Probability Density
5.05	1.25	5.090e-294
5.05	3.75	5.090e-294
5.05	6.25	2.767e-003
5.05	8.75	1.560e-003
5.05	11.25	4.415e-004
5.05	13.75	1.173e-003
5.05	16.25	2.480e-004
5.05	18.75	5.090e-294
5.05	21.25	2.589e-004
5.05	23.75	8.181e-005
5.05	26.25	1.484e-004
5.05	28.75	4.089e-005
5.05	31.25	5.090e-294

5.05	33.75	5.838e-005
5.05	36.25	3.025e-005
5.05	38.75	5.090e-294
5.05	41.25	2.403e-005
5.05	43.75	5.090e-294
5.05	46.25	5.793e-006
5.05	48.75	5.090e-294
5.05	51.25	5.090e-294
5.05	53.75	1.855e-006
5.05	56.25	5.090e-294
5.05	58.75	5.090e-294
5.05	61.25	5.090e-294
5.05	63.75	5.090e-294
5.05	66.25	5.090e-294
5.05	68.75	5.090e-294
5.05	71.25	5.090e-294
5.05	73.75	5.090e-294
5.05	76.25	5.090e-294
5.05	78.75	5.090e-294
5.05	81.25	5.090e-294
5.05	83.75	5.090e-294
5.05	86.25	5.090e-294
5.05	88.75	5.090e-294
5.05	91.25	5.090e-294
5.05	93.75	5.090e-294
5.05	96.25	5.090e-294
5.05	98.75	5.090e-294
5.05	101.25	5.090e-294
5.15	1.25	5.090e-294
5.15	3.75	5.090e-294
5.15	6.25	2.272e-003
5.15	8.75	1.133e-003
5.15	11.25	3.062e-004
5.15	13.75	7.334e-004
5.15	16.25	1.234e-004
5.15	18.75	5.090e-294
5.15	21.25	9.745e-005
5.15	23.75	2.433e-005
5.15	26.25	4.090e-005
5.15	28.75	1.202e-005
5.15	31.25	5.090e-294
5.15	33.75	1.886e-005
5.15	36.25	1.069e-005
5.15	38.75	5.090e-294
5.15	41.25	1.080e-005
5.15	43.75	5.090e-294
5.15	46.25	3.748e-006
5.15	48.75	5.090e-294
5.15	51.25	5.090e-294
5.15	53.75	3.118e-006
5.15	56.25	5.090e-294
5.15	58.75	2.275e-007
5.15	61.25	5.090e-294
5.15	63.75	5.090e-294
5.15	66.25	5.090e-294
5.15	68.75	5.090e-294
5.15	71.25	5.090e-294
5.15	73.75	5.090e-294
5.15	76.25	5.090e-294
5.15	78.75	5.090e-294
5.15	81.25	5.090e-294
5.15	83.75	5.090e-294
5.15	86.25	5.090e-294
5.15	88.75	5.090e-294
5.15	91.25	5.090e-294
5.15	93.75	5.090e-294
5.15	96.25	5.090e-294
5.15	98.75	5.090e-294
5.15	101.25	5.090e-294
5.25	1.25	5.090e-294
5.25	3.75	5.090e-294
5.25	6.25	2.223e-003
5.25	8.75	1.140e-003
5.25	11.25	3.199e-004
5.25	13.75	7.671e-004
5.25	16.25	1.295e-004
5.25	18.75	5.090e-294
5.25	21.25	1.042e-004
5.25	23.75	2.783e-005
5.25	26.25	4.080e-005
5.25	28.75	1.255e-005
5.25	31.25	5.090e-294
5.25	33.75	2.042e-005
5.25	36.25	1.174e-005
5.25	38.75	5.090e-294
5.25	41.25	1.259e-005
5.25	43.75	5.090e-294
5.25	46.25	4.583e-006
5.25	48.75	5.090e-294
5.25	51.25	5.090e-294

5.25	53.75	4.511e-006
5.25	56.25	5.090e-294
5.25	58.75	1.475e-006
5.25	61.25	5.090e-294
5.25	63.75	5.090e-294
5.25	66.25	5.090e-294
5.25	68.75	5.090e-294
5.25	71.25	5.090e-294
5.25	73.75	5.090e-294
5.25	76.25	5.090e-294
5.25	78.75	5.090e-294
5.25	81.25	5.090e-294
5.25	83.75	5.090e-294
5.25	86.25	5.090e-294
5.25	88.75	5.090e-294
5.25	91.25	5.090e-294
5.25	93.75	5.090e-294
5.25	96.25	5.090e-294
5.25	98.75	5.090e-294
5.25	101.25	5.090e-294
5.35	1.25	5.090e-294
5.35	3.75	5.090e-294
5.35	6.25	2.174e-003
5.35	8.75	1.159e-003
5.35	11.25	3.382e-004
5.35	13.75	8.123e-004
5.35	16.25	1.409e-004
5.35	18.75	5.090e-294
5.35	21.25	1.218e-004
5.35	23.75	3.239e-005
5.35	26.25	4.165e-005
5.35	28.75	1.265e-005
5.35	31.25	5.090e-294
5.35	33.75	2.175e-005
5.35	36.25	1.275e-005
5.35	38.75	5.090e-294
5.35	41.25	1.435e-005
5.35	43.75	5.090e-294
5.35	46.25	5.564e-006
5.35	48.75	5.090e-294
5.35	51.25	5.090e-294
5.35	53.75	5.841e-006
5.35	56.25	5.090e-294
5.35	58.75	2.671e-006
5.35	61.25	5.090e-294
5.35	63.75	5.090e-294
5.35	66.25	4.689e-007
5.35	68.75	5.090e-294
5.35	71.25	5.090e-294
5.35	73.75	5.090e-294
5.35	76.25	5.090e-294
5.35	78.75	5.090e-294
5.35	81.25	5.090e-294
5.35	83.75	5.090e-294
5.35	86.25	5.090e-294
5.35	88.75	5.090e-294
5.35	91.25	5.090e-294
5.35	93.75	5.090e-294
5.35	96.25	5.090e-294
5.35	98.75	5.090e-294
5.35	101.25	5.090e-294
5.45	1.25	5.090e-294
5.45	3.75	5.090e-294
5.45	6.25	2.126e-003
5.45	8.75	1.195e-003
5.45	11.25	3.633e-004
5.45	13.75	8.786e-004
5.45	16.25	1.568e-004
5.45	18.75	5.090e-294
5.45	21.25	1.464e-004
5.45	23.75	4.285e-005
5.45	26.25	4.490e-005
5.45	28.75	1.252e-005
5.45	31.25	5.090e-294
5.45	33.75	2.275e-005
5.45	36.25	1.360e-005
5.45	38.75	5.090e-294
5.45	41.25	1.599e-005
5.45	43.75	5.090e-294
5.45	46.25	6.509e-006
5.45	48.75	5.090e-294
5.45	51.25	5.090e-294
5.45	53.75	7.053e-006
5.45	56.25	5.090e-294
5.45	58.75	3.780e-006
5.45	61.25	5.090e-294
5.45	63.75	5.090e-294
5.45	66.25	1.627e-006
5.45	68.75	5.090e-294
5.45	71.25	5.090e-294

5.45	73.75	8.972e-008
5.45	76.25	5.090e-294
5.45	78.75	5.090e-294
5.45	81.25	5.090e-294
5.45	83.75	5.090e-294
5.45	86.25	5.090e-294
5.45	88.75	5.090e-294
5.45	91.25	5.090e-294
5.45	93.75	5.090e-294
5.45	96.25	5.090e-294
5.45	98.75	5.090e-294
5.45	101.25	5.090e-294
5.55	1.25	5.090e-294
5.55	3.75	5.090e-294
5.55	6.25	1.968e-003
5.55	8.75	1.169e-003
5.55	11.25	3.659e-004
5.55	13.75	9.024e-004
5.55	16.25	1.657e-004
5.55	18.75	5.090e-294
5.55	21.25	1.733e-004
5.55	23.75	5.240e-005
5.55	26.25	5.517e-005
5.55	28.75	1.271e-005
5.55	31.25	5.090e-294
5.55	33.75	2.291e-005
5.55	36.25	1.425e-005
5.55	38.75	5.090e-294
5.55	41.25	1.734e-005
5.55	43.75	5.090e-294
5.55	46.25	7.418e-006
5.55	48.75	5.090e-294
5.55	51.25	5.090e-294
5.55	53.75	8.386e-006
5.55	56.25	5.090e-294
5.55	58.75	4.805e-006
5.55	61.25	5.090e-294
5.55	63.75	5.090e-294
5.55	66.25	2.706e-006
5.55	68.75	5.090e-294
5.55	71.25	5.090e-294
5.55	73.75	9.745e-007
5.55	76.25	5.090e-294
5.55	78.75	5.090e-294
5.55	81.25	5.090e-294
5.55	83.75	5.090e-294
5.55	86.25	5.090e-294
5.55	88.75	5.090e-294
5.55	91.25	5.090e-294
5.55	93.75	5.090e-294
5.55	96.25	5.090e-294
5.55	98.75	5.090e-294
5.55	101.25	5.090e-294
5.65	1.25	5.090e-294
5.65	3.75	5.090e-294
5.65	6.25	1.726e-003
5.65	8.75	1.073e-003
5.65	11.25	3.411e-004
5.65	13.75	8.633e-004
5.65	16.25	1.631e-004
5.65	18.75	5.090e-294
5.65	21.25	1.822e-004
5.65	23.75	5.920e-005
5.65	26.25	6.255e-005
5.65	28.75	1.464e-005
5.65	31.25	5.090e-294
5.65	33.75	2.276e-005
5.65	36.25	1.480e-005
5.65	38.75	5.090e-294
5.65	41.25	1.862e-005
5.65	43.75	5.090e-294
5.65	46.25	8.271e-006
5.65	48.75	5.090e-294
5.65	51.25	5.090e-294
5.65	53.75	9.938e-006
5.65	56.25	5.090e-294
5.65	58.75	6.091e-006
5.65	61.25	5.090e-294
5.65	63.75	5.090e-294
5.65	66.25	3.795e-006
5.65	68.75	5.090e-294
5.65	71.25	5.090e-294
5.65	73.75	2.179e-006
5.65	76.25	5.090e-294
5.65	78.75	5.090e-294
5.65	81.25	5.090e-294
5.65	83.75	6.834e-007
5.65	86.25	5.090e-294
5.65	88.75	5.090e-294
5.65	91.25	5.090e-294

5.65	93.75	3.719e-008
5.65	96.25	5.090e-294
5.65	98.75	5.090e-294
5.65	101.25	5.090e-294
5.75	1.25	5.090e-294
5.75	3.75	5.090e-294
5.75	6.25	1.513e-003
5.75	8.75	9.839e-004
5.75	11.25	3.176e-004
5.75	13.75	8.244e-004
5.75	16.25	1.598e-004
5.75	18.75	5.090e-294
5.75	21.25	1.884e-004
5.75	23.75	6.483e-005
5.75	26.25	6.945e-005
5.75	28.75	1.699e-005
5.75	31.25	5.090e-294
5.75	33.75	2.244e-005
5.75	36.25	1.494e-005
5.75	38.75	5.090e-294
5.75	41.25	1.987e-005
5.75	43.75	5.090e-294
5.75	46.25	9.074e-006
5.75	48.75	5.090e-294
5.75	51.25	5.090e-294
5.75	53.75	1.145e-005
5.75	56.25	5.090e-294
5.75	58.75	7.420e-006
5.75	61.25	5.090e-294
5.75	63.75	5.090e-294
5.75	66.25	5.187e-006
5.75	68.75	5.090e-294
5.75	71.25	5.090e-294
5.75	73.75	3.616e-006
5.75	76.25	5.090e-294
5.75	78.75	5.090e-294
5.75	81.25	5.090e-294
5.75	83.75	1.587e-006
5.75	86.25	5.090e-294
5.75	88.75	5.090e-294
5.75	91.25	5.090e-294
5.75	93.75	5.530e-007
5.75	96.25	5.090e-294
5.75	98.75	5.090e-294
5.75	101.25	1.311e-007
5.85	1.25	5.090e-294
5.85	3.75	5.090e-294
5.85	6.25	1.327e-003
5.85	8.75	9.014e-004
5.85	11.25	2.953e-004
5.85	13.75	7.854e-004
5.85	16.25	1.562e-004
5.85	18.75	5.090e-294
5.85	21.25	1.923e-004
5.85	23.75	6.943e-005
5.85	26.25	7.662e-005
5.85	28.75	1.976e-005
5.85	31.25	5.090e-294
5.85	33.75	2.140e-005
5.85	36.25	1.463e-005
5.85	38.75	5.090e-294
5.85	41.25	2.044e-005
5.85	43.75	5.090e-294
5.85	46.25	9.514e-006
5.85	48.75	5.090e-294
5.85	51.25	5.090e-294
5.85	53.75	1.242e-005
5.85	56.25	5.090e-294
5.85	58.75	8.349e-006
5.85	61.25	5.090e-294
5.85	63.75	5.090e-294
5.85	66.25	6.235e-006
5.85	68.75	5.090e-294
5.85	71.25	5.090e-294
5.85	73.75	4.907e-006
5.85	76.25	5.090e-294
5.85	78.75	5.090e-294
5.85	81.25	5.090e-294
5.85	83.75	3.101e-006
5.85	86.25	5.090e-294
5.85	88.75	5.090e-294
5.85	91.25	5.090e-294
5.85	93.75	1.336e-006
5.85	96.25	5.090e-294
5.85	98.75	5.090e-294
5.85	101.25	1.030e-006
5.95	1.25	5.090e-294
5.95	3.75	5.090e-294
5.95	6.25	1.164e-003
5.95	8.75	8.250e-004

5.95	11.25	2.744e-004
5.95	13.75	7.469e-004
5.95	16.25	1.526e-004
5.95	18.75	5.090e-294
5.95	21.25	1.956e-004
5.95	23.75	7.398e-005
5.95	26.25	8.505e-005
5.95	28.75	2.320e-005
5.95	31.25	5.090e-294
5.95	33.75	2.217e-005
5.95	36.25	1.400e-005
5.95	38.75	5.090e-294
5.95	41.25	2.031e-005
5.95	43.75	5.090e-294
5.95	46.25	9.830e-006
5.95	48.75	5.090e-294
5.95	51.25	5.090e-294
5.95	53.75	1.316e-005
5.95	56.25	5.090e-294
5.95	58.75	9.260e-006
5.95	61.25	5.090e-294
5.95	63.75	5.090e-294
5.95	66.25	7.187e-006
5.95	68.75	5.090e-294
5.95	71.25	5.090e-294
5.95	73.75	6.107e-006
5.95	76.25	5.090e-294
5.95	78.75	5.090e-294
5.95	81.25	5.090e-294
5.95	83.75	4.510e-006
5.95	86.25	5.090e-294
5.95	88.75	5.090e-294
5.95	91.25	5.090e-294
5.95	93.75	2.472e-006
5.95	96.25	5.090e-294
5.95	98.75	5.090e-294
5.95	101.25	2.815e-006
6.05	1.25	5.090e-294
6.05	3.75	5.090e-294
6.05	6.25	1.874e-003
6.05	8.75	8.045e-004
6.05	11.25	7.487e-004
6.05	13.75	1.669e-003
6.05	16.25	2.146e-003
6.05	18.75	1.953e-004
6.05	21.25	1.835e-004
6.05	23.75	1.399e-004
6.05	26.25	5.436e-005
6.05	28.75	4.798e-005
6.05	31.25	5.090e-294
6.05	33.75	2.866e-005
6.05	36.25	1.709e-005
6.05	38.75	5.090e-294
6.05	41.25	1.754e-005
6.05	43.75	5.090e-294
6.05	46.25	1.394e-005
6.05	48.75	5.090e-294
6.05	51.25	5.090e-294
6.05	53.75	1.377e-005
6.05	56.25	5.090e-294
6.05	58.75	1.006e-005
6.05	61.25	5.090e-294
6.05	63.75	5.090e-294
6.05	66.25	9.673e-006
6.05	68.75	5.090e-294
6.05	71.25	5.090e-294
6.05	73.75	8.119e-006
6.05	76.25	5.090e-294
6.05	78.75	5.090e-294
6.05	81.25	5.090e-294
6.05	83.75	6.266e-006
6.05	86.25	5.090e-294
6.05	88.75	5.090e-294
6.05	91.25	5.090e-294
6.05	93.75	5.103e-006
6.05	96.25	5.090e-294
6.05	98.75	5.090e-294
6.05	101.25	6.153e-006
6.15	1.25	5.090e-294
6.15	3.75	5.090e-294
6.15	6.25	1.821e-003
6.15	8.75	8.706e-004
6.15	11.25	6.705e-004
6.15	13.75	5.215e-004
6.15	16.25	2.657e-004
6.15	18.75	2.145e-004
6.15	21.25	2.258e-004
6.15	23.75	1.593e-004
6.15	26.25	5.729e-005
6.15	28.75	6.813e-005

6.15	31.25	5.090e-294
6.15	33.75	3.504e-005
6.15	36.25	1.856e-005
6.15	38.75	5.090e-294
6.15	41.25	1.655e-005
6.15	43.75	5.090e-294
6.15	46.25	1.519e-005
6.15	48.75	5.090e-294
6.15	51.25	5.090e-294
6.15	53.75	1.401e-005
6.15	56.25	5.090e-294
6.15	58.75	1.115e-005
6.15	61.25	5.090e-294
6.15	63.75	5.090e-294
6.15	66.25	1.029e-005
6.15	68.75	5.090e-294
6.15	71.25	5.090e-294
6.15	73.75	9.032e-006
6.15	76.25	5.090e-294
6.15	78.75	5.090e-294
6.15	81.25	5.090e-294
6.15	83.75	7.655e-006
6.15	86.25	5.090e-294
6.15	88.75	5.090e-294
6.15	91.25	5.090e-294
6.15	93.75	6.872e-006
6.15	96.25	5.090e-294
6.15	98.75	5.090e-294
6.15	101.25	1.087e-005
6.25	1.25	5.090e-294
6.25	3.75	5.090e-294
6.25	6.25	1.729e-003
6.25	8.75	9.067e-004
6.25	11.25	7.334e-004
6.25	13.75	5.797e-003
6.25	16.25	8.821e-003
6.25	18.75	2.844e-004
6.25	21.25	3.051e-004
6.25	23.75	1.524e-004
6.25	26.25	7.654e-005
6.25	28.75	8.386e-005
6.25	31.25	5.090e-294
6.25	33.75	4.232e-005
6.25	36.25	2.305e-005
6.25	38.75	5.090e-294
6.25	41.25	1.589e-005
6.25	43.75	5.090e-294
6.25	46.25	1.556e-005
6.25	48.75	5.090e-294
6.25	51.25	5.090e-294
6.25	53.75	1.432e-005
6.25	56.25	5.090e-294
6.25	58.75	1.221e-005
6.25	61.25	5.090e-294
6.25	63.75	5.090e-294
6.25	66.25	1.098e-005
6.25	68.75	5.090e-294
6.25	71.25	5.090e-294
6.25	73.75	1.002e-005
6.25	76.25	5.090e-294
6.25	78.75	5.090e-294
6.25	81.25	5.090e-294
6.25	83.75	8.778e-006
6.25	86.25	5.090e-294
6.25	88.75	5.090e-294
6.25	91.25	5.090e-294
6.25	93.75	8.308e-006
6.25	96.25	5.090e-294
6.25	98.75	5.090e-294
6.25	101.25	1.717e-005
6.35	1.25	5.090e-294
6.35	3.75	5.090e-294
6.35	6.25	1.771e-003
6.35	8.75	8.170e-004
6.35	11.25	8.391e-004
6.35	13.75	5.794e-004
6.35	16.25	4.668e-004
6.35	18.75	3.746e-004
6.35	21.25	6.117e-004
6.35	23.75	1.238e-004
6.35	26.25	1.067e-004
6.35	28.75	9.162e-005
6.35	31.25	5.090e-294
6.35	33.75	5.214e-005
6.35	36.25	3.073e-005
6.35	38.75	5.090e-294
6.35	41.25	1.865e-005
6.35	43.75	5.090e-294
6.35	46.25	1.501e-005
6.35	48.75	5.090e-294

6.35	51.25	5.090e-294
6.35	53.75	1.462e-005
6.35	56.25	5.090e-294
6.35	58.75	1.276e-005
6.35	61.25	5.090e-294
6.35	63.75	5.090e-294
6.35	66.25	1.163e-005
6.35	68.75	5.090e-294
6.35	71.25	5.090e-294
6.35	73.75	1.071e-005
6.35	76.25	5.090e-294
6.35	78.75	5.090e-294
6.35	81.25	5.090e-294
6.35	83.75	1.032e-005
6.35	86.25	5.090e-294
6.35	88.75	5.090e-294
6.35	91.25	5.090e-294
6.35	93.75	9.535e-006
6.35	96.25	5.090e-294
6.35	98.75	5.090e-294
6.35	101.25	2.441e-005
6.45	1.25	5.090e-294
6.45	3.75	5.090e-294
6.45	6.25	1.727e-003
6.45	8.75	8.039e-004
6.45	11.25	1.007e-003
6.45	13.75	3.160e-003
6.45	16.25	4.740e-003
6.45	18.75	5.081e-004
6.45	21.25	9.897e-004
6.45	23.75	1.184e-004
6.45	26.25	1.557e-004
6.45	28.75	8.901e-005
6.45	31.25	5.090e-294
6.45	33.75	6.572e-005
6.45	36.25	4.062e-005
6.45	38.75	5.090e-294
6.45	41.25	2.646e-005
6.45	43.75	5.090e-294
6.45	46.25	1.512e-005
6.45	48.75	5.090e-294
6.45	51.25	5.090e-294
6.45	53.75	1.463e-005
6.45	56.25	5.090e-294
6.45	58.75	1.286e-005
6.45	61.25	5.090e-294
6.45	63.75	5.090e-294
6.45	66.25	1.223e-005
6.45	68.75	5.090e-294
6.45	71.25	5.090e-294
6.45	73.75	1.144e-005
6.45	76.25	5.090e-294
6.45	78.75	5.090e-294
6.45	81.25	5.090e-294
6.45	83.75	1.148e-005
6.45	86.25	5.090e-294
6.45	88.75	5.090e-294
6.45	91.25	5.090e-294
6.45	93.75	1.080e-005
6.45	96.25	5.090e-294
6.45	98.75	5.090e-294
6.45	101.25	3.273e-005
6.55	1.25	3.548e-002
6.55	3.75	5.512e-003
6.55	6.25	2.903e-003
6.55	8.75	1.848e-003
6.55	11.25	3.286e-003
6.55	13.75	1.533e-003
6.55	16.25	3.094e-003
6.55	18.75	1.226e-003
6.55	21.25	1.595e-003
6.55	23.75	2.994e-004
6.55	26.25	2.102e-004
6.55	28.75	1.283e-004
6.55	31.25	1.087e-004
6.55	33.75	1.017e-004
6.55	36.25	6.962e-005
6.55	38.75	3.867e-006
6.55	41.25	2.952e-005
6.55	43.75	4.460e-008
6.55	46.25	1.559e-005
6.55	48.75	5.090e-294
6.55	51.25	5.090e-294
6.55	53.75	1.149e-005
6.55	56.25	5.090e-294
6.55	58.75	1.077e-005
6.55	61.25	5.090e-294
6.55	63.75	5.090e-294
6.55	66.25	9.901e-006
6.55	68.75	5.090e-294

6.55	71.25	5.090e-294
6.55	73.75	9.845e-006
6.55	76.25	5.090e-294
6.55	78.75	5.090e-294
6.55	81.25	5.090e-294
6.55	83.75	9.635e-006
6.55	86.25	5.090e-294
6.55	88.75	5.090e-294
6.55	91.25	5.090e-294
6.55	93.75	9.799e-006
6.55	96.25	5.090e-294
6.55	98.75	5.090e-294
6.55	101.25	3.330e-005
6.65	1.25	3.677e-002
6.65	3.75	2.498e-003
6.65	6.25	3.010e-003
6.65	8.75	1.662e-003
6.65	11.25	2.090e-003
6.65	13.75	2.918e-003
6.65	16.25	1.627e-003
6.65	18.75	8.211e-004
6.65	21.25	1.587e-003
6.65	23.75	4.285e-004
6.65	26.25	2.350e-004
6.65	28.75	1.408e-004
6.65	31.25	1.681e-004
6.65	33.75	1.487e-004
6.65	36.25	1.141e-004
6.65	38.75	1.910e-005
6.65	41.25	3.937e-005
6.65	43.75	2.101e-009
6.65	46.25	2.360e-005
6.65	48.75	5.090e-294
6.65	51.25	5.090e-294
6.65	53.75	1.306e-005
6.65	56.25	5.090e-294
6.65	58.75	1.093e-005
6.65	61.25	5.090e-294
6.65	63.75	5.090e-294
6.65	66.25	1.017e-005
6.65	68.75	5.090e-294
6.65	71.25	5.090e-294
6.65	73.75	1.043e-005
6.65	76.25	5.090e-294
6.65	78.75	5.090e-294
6.65	81.25	5.090e-294
6.65	83.75	1.009e-005
6.65	86.25	5.090e-294
6.65	88.75	5.090e-294
6.65	91.25	5.090e-294
6.65	93.75	1.076e-005
6.65	96.25	5.090e-294
6.65	98.75	5.090e-294
6.65	101.25	4.067e-005
6.75	1.25	4.459e-002
6.75	3.75	2.921e-003
6.75	6.25	2.415e-003
6.75	8.75	1.758e-003
6.75	11.25	2.490e-003
6.75	13.75	4.553e-003
6.75	16.25	1.173e-003
6.75	18.75	3.985e-003
6.75	21.25	3.047e-003
6.75	23.75	1.285e-003
6.75	26.25	2.451e-004
6.75	28.75	1.726e-004
6.75	31.25	2.451e-004
6.75	33.75	2.402e-004
6.75	36.25	2.128e-004
6.75	38.75	4.427e-005
6.75	41.25	5.584e-005
6.75	43.75	1.479e-007
6.75	46.25	3.389e-005
6.75	48.75	5.090e-294
6.75	51.25	5.090e-294
6.75	53.75	1.848e-005
6.75	56.25	5.090e-294
6.75	58.75	1.165e-005
6.75	61.25	5.090e-294
6.75	63.75	5.090e-294
6.75	66.25	1.056e-005
6.75	68.75	5.090e-294
6.75	71.25	5.090e-294
6.75	73.75	1.054e-005
6.75	76.25	5.090e-294
6.75	78.75	5.090e-294
6.75	81.25	5.090e-294
6.75	83.75	1.052e-005
6.75	86.25	5.090e-294
6.75	88.75	5.090e-294

6.75	91.25	5.090e-294
6.75	93.75	1.211e-005
6.75	96.25	5.090e-294
6.75	98.75	5.090e-294
6.75	101.25	4.782e-005
6.85	1.25	5.636e-002
6.85	3.75	3.255e-003
6.85	6.25	2.983e-003
6.85	8.75	1.399e-003
6.85	11.25	3.486e-003
6.85	13.75	8.813e-003
6.85	16.25	8.377e-004
6.85	18.75	7.005e-004
6.85	21.25	1.003e-003
6.85	23.75	4.688e-004
6.85	26.25	2.671e-004
6.85	28.75	1.373e-004
6.85	31.25	3.107e-004
6.85	33.75	3.478e-004
6.85	36.25	3.099e-004
6.85	38.75	9.237e-005
6.85	41.25	6.780e-005
6.85	43.75	2.543e-006
6.85	46.25	3.839e-005
6.85	48.75	5.090e-294
6.85	51.25	5.090e-294
6.85	53.75	2.427e-005
6.85	56.25	5.090e-294
6.85	58.75	1.277e-005
6.85	61.25	5.090e-294
6.85	63.75	5.090e-294
6.85	66.25	1.013e-005
6.85	68.75	5.090e-294
6.85	71.25	5.090e-294
6.85	73.75	1.049e-005
6.85	76.25	5.090e-294
6.85	78.75	5.090e-294
6.85	81.25	5.090e-294
6.85	83.75	1.057e-005
6.85	86.25	5.090e-294
6.85	88.75	5.090e-294
6.85	91.25	5.090e-294
6.85	93.75	1.287e-005
6.85	96.25	5.090e-294
6.85	98.75	5.090e-294
6.85	101.25	5.344e-005
6.95	1.25	8.822e-002
6.95	3.75	2.611e-003
6.95	6.25	1.121e-003
6.95	8.75	4.589e-004
6.95	11.25	4.981e-003
6.95	13.75	1.409e-002
6.95	16.25	9.713e-004
6.95	18.75	1.342e-002
6.95	21.25	7.377e-003
6.95	23.75	3.867e-003
6.95	26.25	1.553e-004
6.95	28.75	1.423e-004
6.95	31.25	3.397e-004
6.95	33.75	3.837e-004
6.95	36.25	4.446e-004
6.95	38.75	1.266e-004
6.95	41.25	6.732e-005
6.95	43.75	9.074e-006
6.95	46.25	4.412e-005
6.95	48.75	1.255e-007
6.95	51.25	5.090e-294
6.95	53.75	2.837e-005
6.95	56.25	5.090e-294
6.95	58.75	1.681e-005
6.95	61.25	5.090e-294
6.95	63.75	5.090e-294
6.95	66.25	1.024e-005
6.95	68.75	5.090e-294
6.95	71.25	5.090e-294
6.95	73.75	9.936e-006
6.95	76.25	5.090e-294
6.95	78.75	5.090e-294
6.95	81.25	5.090e-294
6.95	83.75	1.131e-005
6.95	86.25	5.090e-294
6.95	88.75	5.090e-294
6.95	91.25	5.090e-294
6.95	93.75	1.272e-005
6.95	96.25	5.090e-294
6.95	98.75	5.090e-294
6.95	101.25	5.855e-005
7.05	1.25	1.140e-001
7.05	3.75	5.090e-294
7.05	6.25	1.149e-003

7.05	8.75	4.688e-004
7.05	11.25	5.975e-003
7.05	13.75	1.771e-002
7.05	16.25	8.536e-004
7.05	18.75	5.344e-004
7.05	21.25	3.373e-004
7.05	23.75	1.930e-004
7.05	26.25	1.849e-004
7.05	28.75	1.242e-004
7.05	31.25	3.201e-004
7.05	33.75	3.769e-004
7.05	36.25	4.774e-004
7.05	38.75	1.040e-004
7.05	41.25	6.506e-005
7.05	43.75	2.712e-005
7.05	46.25	5.094e-005
7.05	48.75	1.475e-006
7.05	51.25	7.739e-007
7.05	53.75	2.892e-005
7.05	56.25	5.090e-294
7.05	58.75	1.646e-005
7.05	61.25	5.090e-294
7.05	63.75	5.090e-294
7.05	66.25	6.614e-006
7.05	68.75	5.090e-294
7.05	71.25	5.090e-294
7.05	73.75	3.653e-006
7.05	76.25	5.090e-294
7.05	78.75	5.090e-294
7.05	81.25	5.090e-294
7.05	83.75	4.240e-006
7.05	86.25	5.090e-294
7.05	88.75	5.090e-294
7.05	91.25	5.090e-294
7.05	93.75	4.728e-006
7.05	96.25	5.090e-294
7.05	98.75	5.090e-294
7.05	101.25	2.357e-005
7.15	1.25	1.193e-001
7.15	3.75	5.090e-294
7.15	6.25	1.148e-003
7.15	8.75	3.993e-004
7.15	11.25	5.688e-003
7.15	13.75	1.565e-002
7.15	16.25	2.169e-004
7.15	18.75	5.559e-003
7.15	21.25	3.149e-003
7.15	23.75	1.778e-003
7.15	26.25	1.743e-004
7.15	28.75	1.305e-004
7.15	31.25	2.219e-004
7.15	33.75	3.056e-004
7.15	36.25	4.005e-004
7.15	38.75	8.242e-005
7.15	41.25	7.705e-005
7.15	43.75	5.089e-005
7.15	46.25	5.714e-005
7.15	48.75	7.251e-006
7.15	51.25	7.506e-006
7.15	53.75	3.922e-005
7.15	56.25	1.391e-005
7.15	58.75	2.244e-005
7.15	61.25	5.090e-294
7.15	63.75	5.090e-294
7.15	66.25	1.187e-005
7.15	68.75	5.090e-294
7.15	71.25	5.090e-294
7.15	73.75	4.727e-006
7.15	76.25	5.090e-294
7.15	78.75	5.090e-294
7.15	81.25	5.090e-294
7.15	83.75	3.987e-006
7.15	86.25	5.090e-294
7.15	88.75	5.090e-294
7.15	91.25	5.090e-294
7.15	93.75	4.677e-006
7.15	96.25	5.090e-294
7.15	98.75	5.090e-294
7.15	101.25	2.497e-005
7.25	1.25	8.754e-002
7.25	3.75	1.640e-006
7.25	6.25	8.660e-004
7.25	8.75	4.134e-004
7.25	11.25	3.466e-003
7.25	13.75	9.724e-003
7.25	16.25	2.122e-004
7.25	18.75	2.267e-004
7.25	21.25	1.905e-004
7.25	23.75	1.921e-004
7.25	26.25	1.833e-004

7.25	28.75	1.388e-004
7.25	31.25	1.102e-004
7.25	33.75	2.173e-004
7.25	36.25	2.707e-004
7.25	38.75	4.473e-005
7.25	41.25	8.403e-005
7.25	43.75	6.108e-005
7.25	46.25	6.797e-005
7.25	48.75	1.944e-005
7.25	51.25	2.454e-005
7.25	53.75	4.676e-005
7.25	56.25	5.476e-005
7.25	58.75	3.005e-005
7.25	61.25	2.379e-009
7.25	63.75	5.090e-294
7.25	66.25	1.671e-005
7.25	68.75	5.090e-294
7.25	71.25	5.090e-294
7.25	73.75	7.706e-006
7.25	76.25	5.090e-294
7.25	78.75	5.090e-294
7.25	81.25	5.090e-294
7.25	83.75	3.947e-006
7.25	86.25	5.090e-294
7.25	88.75	5.090e-294
7.25	91.25	5.090e-294
7.25	93.75	4.700e-006
7.25	96.25	5.090e-294
7.25	98.75	5.090e-294
7.25	101.25	2.595e-005
7.35	1.25	5.137e-002
7.35	3.75	5.090e-294
7.35	6.25	9.510e-004
7.35	8.75	3.694e-004
7.35	11.25	1.630e-003
7.35	13.75	4.437e-003
7.35	16.25	2.057e-004
7.35	18.75	1.998e-004
7.35	21.25	2.032e-004
7.35	23.75	1.918e-004
7.35	26.25	1.890e-004
7.35	28.75	1.348e-004
7.35	31.25	4.248e-005
7.35	33.75	1.713e-004
7.35	36.25	1.733e-004
7.35	38.75	1.834e-005
7.35	41.25	9.368e-005
7.35	43.75	5.332e-005
7.35	46.25	7.668e-005
7.35	48.75	3.828e-005
7.35	51.25	1.247e-005
7.35	53.75	5.177e-005
7.35	56.25	9.852e-005
7.35	58.75	3.684e-005
7.35	61.25	1.085e-008
7.35	63.75	1.303e-010
7.35	66.25	2.228e-005
7.35	68.75	5.090e-294
7.35	71.25	5.090e-294
7.35	73.75	1.185e-005
7.35	76.25	5.090e-294
7.35	78.75	5.090e-294
7.35	81.25	5.090e-294
7.35	83.75	5.609e-006
7.35	86.25	5.090e-294
7.35	88.75	5.090e-294
7.35	91.25	5.090e-294
7.35	93.75	4.586e-006
7.35	96.25	5.090e-294
7.35	98.75	5.090e-294
7.35	101.25	2.654e-005
7.45	1.25	2.042e-002
7.45	3.75	3.866e-006
7.45	6.25	1.008e-003
7.45	8.75	4.056e-004
7.45	11.25	8.466e-004
7.45	13.75	1.734e-003
7.45	16.25	2.164e-004
7.45	18.75	2.028e-004
7.45	21.25	2.256e-004
7.45	23.75	1.834e-004
7.45	26.25	1.992e-004
7.45	28.75	1.613e-004
7.45	31.25	4.480e-008
7.45	33.75	1.529e-004
7.45	36.25	1.151e-004
7.45	38.75	2.932e-008
7.45	41.25	1.069e-004
7.45	43.75	2.871e-005
7.45	46.25	8.511e-005

7.45	48.75	5.088e-005
7.45	51.25	1.923e-005
7.45	53.75	6.425e-005
7.45	56.25	1.036e-004
7.45	58.75	4.402e-005
7.45	61.25	9.012e-010
7.45	63.75	3.991e-010
7.45	66.25	3.034e-005
7.45	68.75	5.090e-294
7.45	71.25	5.090e-294
7.45	73.75	1.699e-005
7.45	76.25	5.090e-294
7.45	78.75	5.090e-294
7.45	81.25	5.090e-294
7.45	83.75	9.423e-006
7.45	86.25	5.090e-294
7.45	88.75	5.090e-294
7.45	91.25	5.090e-294
7.45	93.75	4.940e-006
7.45	96.25	5.090e-294
7.45	98.75	5.090e-294
7.45	101.25	2.683e-005
7.55	1.25	6.465e-003
7.55	3.75	5.090e-294
7.55	6.25	1.718e-004
7.55	8.75	6.132e-005
7.55	11.25	5.945e-005
7.55	13.75	6.385e-005
7.55	16.25	2.229e-005
7.55	18.75	3.117e-005
7.55	21.25	2.870e-005
7.55	23.75	2.777e-005
7.55	26.25	2.440e-005
7.55	28.75	2.170e-005
7.55	31.25	5.090e-294
7.55	33.75	2.150e-005
7.55	36.25	1.672e-005
7.55	38.75	5.090e-294
7.55	41.25	1.566e-005
7.55	43.75	1.201e-005
7.55	46.25	1.255e-005
7.55	48.75	3.975e-005
7.55	51.25	5.090e-294
7.55	53.75	1.023e-005
7.55	56.25	6.589e-005
7.55	58.75	7.367e-006
7.55	61.25	5.090e-294
7.55	63.75	5.090e-294
7.55	66.25	5.550e-006
7.55	68.75	5.090e-294
7.55	71.25	5.090e-294
7.55	73.75	3.768e-006
7.55	76.25	5.090e-294
7.55	78.75	5.090e-294
7.55	81.25	5.090e-294
7.55	83.75	2.564e-006
7.55	86.25	5.090e-294
7.55	88.75	5.090e-294
7.55	91.25	5.090e-294
7.55	93.75	1.690e-006
7.55	96.25	5.090e-294
7.55	98.75	5.090e-294
7.55	101.25	8.940e-006
7.65	1.25	2.043e-005
7.65	3.75	5.530e-007
7.65	6.25	1.720e-004
7.65	8.75	6.505e-005
7.65	11.25	5.972e-005
7.65	13.75	6.522e-005
7.65	16.25	2.747e-005
7.65	18.75	3.158e-005
7.65	21.25	2.703e-005
7.65	23.75	3.026e-005
7.65	26.25	2.839e-005
7.65	28.75	2.289e-005
7.65	31.25	1.761e-008
7.65	33.75	2.416e-005
7.65	36.25	1.986e-005
7.65	38.75	1.265e-008
7.65	41.25	1.802e-005
7.65	43.75	7.281e-009
7.65	46.25	1.574e-005
7.65	48.75	2.360e-005
7.65	51.25	5.459e-010
7.65	53.75	1.311e-005
7.65	56.25	3.012e-005
7.65	58.75	1.072e-005
7.65	61.25	1.063e-009
7.65	63.75	6.143e-010
7.65	66.25	8.514e-006

7.65	68.75	2.812e-010
7.65	71.25	2.891e-010
7.65	73.75	6.795e-006
7.65	76.25	5.484e-011
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7.65	81.25	5.090e-294
7.65	83.75	5.684e-006
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7.65	88.75	5.090e-294
7.65	91.25	5.090e-294
7.65	93.75	5.167e-006
7.65	96.25	5.090e-294
7.65	98.75	5.090e-294
7.65	101.25	2.602e-005
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7.75	3.75	5.090e-294
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7.75	8.75	6.268e-005
7.75	11.25	5.416e-005
7.75	13.75	6.850e-005
7.75	16.25	2.678e-005
7.75	18.75	2.758e-005
7.75	21.25	2.991e-005
7.75	23.75	3.068e-005
7.75	26.25	2.468e-005
7.75	28.75	2.505e-005
7.75	31.25	5.090e-294
7.75	33.75	2.305e-005
7.75	36.25	2.020e-005
7.75	38.75	5.090e-294
7.75	41.25	1.799e-005
7.75	43.75	5.090e-294
7.75	46.25	1.551e-005
7.75	48.75	9.968e-006
7.75	51.25	5.090e-294
7.75	53.75	1.282e-005
7.75	56.25	5.090e-294
7.75	58.75	1.028e-005
7.75	61.25	5.090e-294
7.75	63.75	5.090e-294
7.75	66.25	7.515e-006
7.75	68.75	5.090e-294
7.75	71.25	5.090e-294
7.75	73.75	4.695e-006
7.75	76.25	5.090e-294
7.75	78.75	5.090e-294
7.75	81.25	5.090e-294
7.75	83.75	2.971e-006
7.75	86.25	5.090e-294
7.75	88.75	5.090e-294
7.75	91.25	5.090e-294
7.75	93.75	1.488e-006
7.75	96.25	5.090e-294
7.75	98.75	5.090e-294
7.75	101.25	4.425e-007
7.85	1.25	5.090e-294
7.85	3.75	5.090e-294
7.85	6.25	1.759e-004
7.85	8.75	6.121e-005
7.85	11.25	5.689e-005
7.85	13.75	6.492e-005
7.85	16.25	3.046e-005
7.85	18.75	3.020e-005
7.85	21.25	2.949e-005
7.85	23.75	2.969e-005
7.85	26.25	2.878e-005
7.85	28.75	2.430e-005
7.85	31.25	5.090e-294
7.85	33.75	2.631e-005
7.85	36.25	2.162e-005
7.85	38.75	5.090e-294
7.85	41.25	2.006e-005
7.85	43.75	5.090e-294
7.85	46.25	1.776e-005
7.85	48.75	5.090e-294
7.85	51.25	5.090e-294
7.85	53.75	1.420e-005
7.85	56.25	5.090e-294
7.85	58.75	1.174e-005
7.85	61.25	5.090e-294
7.85	63.75	5.090e-294
7.85	66.25	8.912e-006
7.85	68.75	5.090e-294
7.85	71.25	5.090e-294
7.85	73.75	6.027e-006
7.85	76.25	5.090e-294
7.85	78.75	5.090e-294
7.85	81.25	5.090e-294
7.85	83.75	3.919e-006
7.85	86.25	5.090e-294

7.85	88.75	5.090e-294
7.85	91.25	5.090e-294
7.85	93.75	2.284e-006
7.85	96.25	5.090e-294
7.85	98.75	5.090e-294
7.85	101.25	1.170e-006
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7.95	3.75	5.090e-294
7.95	6.25	1.748e-004
7.95	8.75	6.100e-005
7.95	11.25	5.912e-005
7.95	13.75	6.451e-005
7.95	16.25	3.365e-005
7.95	18.75	2.625e-005
7.95	21.25	3.248e-005
7.95	23.75	3.172e-005
7.95	26.25	2.964e-005
7.95	28.75	2.605e-005
7.95	31.25	5.090e-294
7.95	33.75	2.873e-005
7.95	36.25	2.313e-005
7.95	38.75	5.090e-294
7.95	41.25	2.224e-005
7.95	43.75	5.090e-294
7.95	46.25	1.821e-005
7.95	48.75	5.090e-294
7.95	51.25	5.090e-294
7.95	53.75	1.584e-005
7.95	56.25	5.090e-294
7.95	58.75	1.338e-005
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7.95	63.75	5.090e-294
7.95	66.25	1.039e-005
7.95	68.75	5.090e-294
7.95	71.25	5.090e-294
7.95	73.75	7.588e-006
7.95	76.25	5.090e-294
7.95	78.75	5.090e-294
7.95	81.25	5.090e-294
7.95	83.75	5.267e-006
7.95	86.25	5.090e-294
7.95	88.75	5.090e-294
7.95	91.25	5.090e-294
7.95	93.75	3.324e-006
7.95	96.25	5.090e-294
7.95	98.75	5.090e-294
7.95	101.25	2.125e-006
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8.05	3.75	5.090e-294
8.05	6.25	5.090e-294
8.05	8.75	5.090e-294
8.05	11.25	5.090e-294
8.05	13.75	5.090e-294
8.05	16.25	5.090e-294
8.05	18.75	5.090e-294
8.05	21.25	5.090e-294
8.05	23.75	5.090e-294
8.05	26.25	5.090e-294
8.05	28.75	5.090e-294
8.05	31.25	5.090e-294
8.05	33.75	5.090e-294
8.05	36.25	5.090e-294
8.05	38.75	5.090e-294
8.05	41.25	5.090e-294
8.05	43.75	5.090e-294
8.05	46.25	5.090e-294
8.05	48.75	5.090e-294
8.05	51.25	5.090e-294
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8.05	58.75	5.090e-294
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8.05	63.75	5.090e-294
8.05	66.25	5.090e-294
8.05	68.75	5.090e-294
8.05	71.25	5.090e-294
8.05	73.75	5.090e-294
8.05	76.25	5.090e-294
8.05	78.75	5.090e-294
8.05	81.25	5.090e-294
8.05	83.75	5.090e-294
8.05	86.25	5.090e-294
8.05	88.75	5.090e-294
8.05	91.25	5.090e-294
8.05	93.75	5.090e-294
8.05	96.25	5.090e-294
8.05	98.75	5.090e-294
8.05	101.25	5.090e-294
8.15	1.25	5.090e-294
8.15	3.75	5.090e-294

8.15	6.25	5.090e-294
8.15	8.75	5.090e-294
8.15	11.25	5.090e-294
8.15	13.75	5.090e-294
8.15	16.25	5.090e-294
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8.15	23.75	5.090e-294
8.15	26.25	5.090e-294
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8.15	31.25	5.090e-294
8.15	33.75	5.090e-294
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8.15	38.75	5.090e-294
8.15	41.25	5.090e-294
8.15	43.75	5.090e-294
8.15	46.25	5.090e-294
8.15	48.75	5.090e-294
8.15	51.25	5.090e-294
8.15	53.75	5.090e-294
8.15	56.25	5.090e-294
8.15	58.75	5.090e-294
8.15	61.25	5.090e-294
8.15	63.75	5.090e-294
8.15	66.25	5.090e-294
8.15	68.75	5.090e-294
8.15	71.25	5.090e-294
8.15	73.75	5.090e-294
8.15	76.25	5.090e-294
8.15	78.75	5.090e-294
8.15	81.25	5.090e-294
8.15	83.75	5.090e-294
8.15	86.25	5.090e-294
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8.25	18.75	5.090e-294
8.25	21.25	5.090e-294
8.25	23.75	5.090e-294
8.25	26.25	5.090e-294
8.25	28.75	5.090e-294
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8.25	66.25	5.090e-294
8.25	68.75	5.090e-294
8.25	71.25	5.090e-294
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8.25	91.25	5.090e-294
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8.25	96.25	5.090e-294
8.25	98.75	5.090e-294
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8.35	48.75	5.090e-294
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8.35	86.25	5.090e-294
8.35	88.75	5.090e-294
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8.35	93.75	5.090e-294
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8.45	13.75	5.090e-294
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8.45	18.75	5.090e-294
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8.45	76.25	5.090e-294
8.45	78.75	5.090e-294
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8.45	83.75	5.090e-294
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8.45	91.25	5.090e-294
8.45	93.75	5.090e-294
8.45	96.25	5.090e-294
8.45	98.75	5.090e-294
8.45	101.25	5.090e-294
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8.55	66.25	5.090e-294
8.55	68.75	5.090e-294
8.55	71.25	5.090e-294
8.55	73.75	5.090e-294
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8.65	38.75	5.090e-294
8.65	41.25	5.090e-294
8.65	43.75	5.090e-294
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8.65	56.25	5.090e-294
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8.65	66.25	5.090e-294
8.65	68.75	5.090e-294
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8.65	78.75	5.090e-294
8.65	81.25	5.090e-294
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8.65	101.25	5.090e-294
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8.75	6.25	5.090e-294
8.75	8.75	5.090e-294
8.75	11.25	5.090e-294
8.75	13.75	5.090e-294
8.75	16.25	5.090e-294
8.75	18.75	5.090e-294
8.75	21.25	5.090e-294
8.75	23.75	5.090e-294
8.75	26.25	5.090e-294
8.75	28.75	5.090e-294
8.75	31.25	5.090e-294
8.75	33.75	5.090e-294
8.75	36.25	5.090e-294
8.75	38.75	5.090e-294
8.75	41.25	5.090e-294
8.75	43.75	5.090e-294
8.75	46.25	5.090e-294
8.75	48.75	5.090e-294
8.75	51.25	5.090e-294
8.75	53.75	5.090e-294
8.75	56.25	5.090e-294
8.75	58.75	5.090e-294
8.75	61.25	5.090e-294
8.75	63.75	5.090e-294

8.75	66.25	5.090e-294
8.75	68.75	5.090e-294
8.75	71.25	5.090e-294
8.75	73.75	5.090e-294
8.75	76.25	5.090e-294
8.75	78.75	5.090e-294
8.75	81.25	5.090e-294
8.75	83.75	5.090e-294
8.75	86.25	5.090e-294
8.75	88.75	5.090e-294
8.75	91.25	5.090e-294
8.75	93.75	5.090e-294
8.75	96.25	5.090e-294
8.75	98.75	5.090e-294
8.75	101.25	5.090e-294
8.85	1.25	5.090e-294
8.85	3.75	5.090e-294
8.85	6.25	5.090e-294
8.85	8.75	5.090e-294
8.85	11.25	5.090e-294
8.85	13.75	5.090e-294
8.85	16.25	5.090e-294
8.85	18.75	5.090e-294
8.85	21.25	5.090e-294
8.85	23.75	5.090e-294
8.85	26.25	5.090e-294
8.85	28.75	5.090e-294
8.85	31.25	5.090e-294
8.85	33.75	5.090e-294
8.85	36.25	5.090e-294
8.85	38.75	5.090e-294
8.85	41.25	5.090e-294
8.85	43.75	5.090e-294
8.85	46.25	5.090e-294
8.85	48.75	5.090e-294
8.85	51.25	5.090e-294
8.85	53.75	5.090e-294
8.85	56.25	5.090e-294
8.85	58.75	5.090e-294
8.85	61.25	5.090e-294
8.85	63.75	5.090e-294
8.85	66.25	5.090e-294
8.85	68.75	5.090e-294
8.85	71.25	5.090e-294
8.85	73.75	5.090e-294
8.85	76.25	5.090e-294
8.85	78.75	5.090e-294
8.85	81.25	5.090e-294
8.85	83.75	5.090e-294
8.85	86.25	5.090e-294
8.85	88.75	5.090e-294
8.85	91.25	5.090e-294
8.85	93.75	5.090e-294
8.85	96.25	5.090e-294
8.85	98.75	5.090e-294
8.85	101.25	5.090e-294
8.95	1.25	5.090e-294
8.95	3.75	5.090e-294
8.95	6.25	5.090e-294
8.95	8.75	5.090e-294
8.95	11.25	5.090e-294
8.95	13.75	5.090e-294
8.95	16.25	5.090e-294
8.95	18.75	5.090e-294
8.95	21.25	5.090e-294
8.95	23.75	5.090e-294
8.95	26.25	5.090e-294
8.95	28.75	5.090e-294
8.95	31.25	5.090e-294
8.95	33.75	5.090e-294
8.95	36.25	5.090e-294
8.95	38.75	5.090e-294
8.95	41.25	5.090e-294
8.95	43.75	5.090e-294
8.95	46.25	5.090e-294
8.95	48.75	5.090e-294
8.95	51.25	5.090e-294
8.95	53.75	5.090e-294
8.95	56.25	5.090e-294
8.95	58.75	5.090e-294
8.95	61.25	5.090e-294
8.95	63.75	5.090e-294
8.95	66.25	5.090e-294
8.95	68.75	5.090e-294
8.95	71.25	5.090e-294
8.95	73.75	5.090e-294
8.95	76.25	5.090e-294
8.95	78.75	5.090e-294
8.95	81.25	5.090e-294
8.95	83.75	5.090e-294

8.95	86.25	5.090e-294
8.95	88.75	5.090e-294
8.95	91.25	5.090e-294
8.95	93.75	5.090e-294
8.95	96.25	5.090e-294
8.95	98.75	5.090e-294
8.95	101.25	5.090e-294

Integral: 1.000e+000

DEAGGREGATION: Summary by Source

Spectral Period: PGA
Amplitude: 0.5
Annual Frequency of Exceedance: 5.478e-004

Source	Region	Magnitude Mode	Magnitude Mean	Distance Mode	Distance Mean	Epsilon Mode	Epsilon Mean	Contribution %
CEUS Gridded Source	USGS 2014 CEUS Gridded Source	5.05	5.68	13.75	28.84	0.70	0.76	0.97
Shallow - Extensional Gridded	USGS 2014 WUS Gridded Source	6.45	6.27	6.25	12.33	1.10	1.27	10.48
Wasatch fault, Weber section [2351e]	USGS 2014 Utah	7.15	7.03	1.25	1.25	-0.10	0.11	69.49
Salt Lake City - Wasatch Fault Source Model	USGS 2014 Utah	6.95	6.92	13.75	15.41	1.10	1.31	17.01
Morgan fault [2353abc]	USGS 2014 Utah	6.55	6.54	11.25	13.36	1.10	0.95	0.78
West Valley fault [2386]	USGS 2014 Utah	6.55	6.56	21.25	20.38	1.90	1.94	0.16
W65G35 West Valley (Wasatch 65) fault (dip 35)	USGS 2014 Utah	6.55	6.56	18.75	19.23	1.90	2.01	0.03
W50G35 West Valley (Wasatch 50) fault (dip 35)	USGS 2014 Utah	6.55	6.56	18.75	19.64	2.10	2.09	0.08
W35G35 West Valley (Wasatch 35) fault (dip 35)	USGS 2014 Utah	6.55	6.56	21.25	20.22	2.10	2.19	0.02
W65G50 West Valley (Wasatch 65) fault (dip 50)	USGS 2014 Utah	6.55	6.56	21.25	20.82	2.10	2.14	0.07
W50G50 West Valley (Wasatch 50) fault (dip 50)	USGS 2014 Utah	6.55	6.56	21.25	20.95	2.10	2.21	0.17
W35G50 West Valley (Wasatch 35) fault (dip 50)	USGS 2014 Utah	6.65	6.57	21.25	21.33	2.10	2.24	0.05
W50G65 West Valley (Wasatch 50) fault (dip 65)	USGS 2014 Utah	6.65	6.57	21.25	22.46	2.10	2.26	0.04
W65G65 West Valley (Wasatch 65) fault (dip 65)	USGS 2014 Utah	6.65	6.56	21.25	22.46	2.10	2.23	0.02
W35G65 West Valley (Wasatch 35) fault (dip 65)	USGS 2014 Utah	6.65	6.57	21.25	22.47	2.10	2.29	0.01
Great Salt Lake fault zone, Antelope Island [2369c]	USGS 2014 Utah	6.95	6.92	31.25	30.50	2.30	2.40	0.18
Great Salt Lake fault zone, Fremont Island s [2369b]	USGS 2014 Utah	6.85	6.89	33.75	34.26	2.50	2.56	0.06
Wasatch fault, Brigham City section [2351d]	USGS 2014 Utah	7.05	7.02	36.25	36.30	2.50	2.51	0.29
Oquirrh-Southern Oquirrh Mountains fault [2398_2399]	USGS 2014 Utah	7.25	7.27	43.75	44.46	2.50	2.59	0.03
East Cache fault zone [2352abc]	USGS 2014 Utah	7.45	7.42	48.75	49.15	2.70	2.58	0.02
Great Salt Lake fault zone, Promontory secti [2369a]	USGS 2014 Utah	7.25	7.29	51.25	51.88	2.90	2.76	0.01
Wasatch fault, Provo section [2351g]	USGS 2014 Utah	7.45	7.44	56.25	55.49	2.70	2.71	0.04
West Cache fault, Wellsville section [2521c]	USGS 2014 Utah	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Stansbury fault zone [2395]	USGS 2014 Utah	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Bear River fault zone [730]	USGS 2014 Wyoming	N/A	N/A	N/A	N/A	N/A	N/A	0.00
West Cache fault zone, Junction Hills fault [2521b]	USGS 2014 Utah	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Hansel Valley fault [2358]	USGS 2014 Utah	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Eastern Bear Lake fault [2364abc]	USGS 2014 Idaho	N/A	N/A	N/A	N/A	N/A	N/A	0.00
North Promontory fault [2361]	USGS 2014 Nevada	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Strawberry fault [2412]	USGS 2014 Utah	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Wasatch fault, Nephi section [2351h]	USGS 2014 Utah	N/A	N/A	N/A	N/A	N/A	N/A	0.00
West Cache fault, Clarkston section [2521a]	USGS 2014 Utah	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Rock Creek fault [729]	USGS 2014 Wyoming	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Wasatch fault, Levan section [2351i]	USGS 2014 Utah	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Joes Valley fault zone [2455]	USGS 2014 Utah	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Grand Valley fault [726c]	USGS 2014 Wyoming	N/A	N/A	N/A	N/A	N/A	N/A	0.00
Greys River fault [728]	USGS 2014 Wyoming	N/A	N/A	N/A	N/A	N/A	N/A	0.00

DEAGGREGATION: Conditional Mean Spectrum by Source

Period	0.01	0.02	0.03	0.05
0.075	0.1	0.15	0.2	0.25	0.3	0.4	0.5	0.75	1	1.5	2
3	4	5	7.5	10							
CEUS Gridded Source	USGS 2014 CEUS Gridded Source	0.500000	0.631066	0.726902	0.780549						
0.851555	0.914845	0.832170	0.753269	0.621345	0.534061	0.348704	0.251983	0.142268	0.092607	0.044418	
0.025619	0.012051	0.008835	0.006514	0.002603	0.001530						
Shallow - Extensional Gridded	USGS 2014 WUS Gridded Source	0.500000	0.462069	0.468778	0.526078						
0.646957	0.770344	0.981863	1.096881	1.100724	1.072397	0.950487	0.832463	0.563870	0.405469	0.231400	
0.146875	0.070781	0.039774	0.024398	0.008993	0.004822						
Wasatch fault, Weber section [2351e]	USGS 2014 Utah	0.500000	0.500458	0.497601	0.531034						
0.611884	0.697936	0.852272	0.984086	1.073467	1.141142	1.178324	1.143499	0.970779	0.812783	0.581677	
0.437612	0.270299	0.171536	0.116202	0.047621	0.026071						
Salt Lake City - Wasatch Fault Source Model	USGS 2014 Utah	0.500000	0.467049	0.471488	0.524061						
0.632657	0.743909	0.946732	1.076548	1.102146	1.104729	1.032826	0.932662	0.678658	0.513192	0.324811	
0.222138	0.122776	0.074798	0.050275	0.020975	0.012137						
Morgan fault [2353abc]	USGS 2014 Utah	0.500000	0.478662	0.486187	0.544867						
0.654102	0.761084	0.935908	1.068139	1.095431	1.105331	1.035213	0.944033	0.708962	0.522053	0.319879	
0.216786	0.111443	0.063373	0.039621	0.014326	0.007620						
West Valley fault [2386]	USGS 2014 Utah	0.500000	0.450160	0.461533	0.532567						
0.662199	0.786202	0.999021	1.109837	1.090581	1.052075	0.921162	0.800893	0.540311	0.384224	0.221059	
0.141091	0.071129	0.040777	0.025843	0.009763	0.005595						
W65G35 West Valley (Wasatch 65) fault (dip 35)	USGS 2014 Utah	0.500000	0.448510	0.459242	0.528467						
0.656840	0.782783	1.001793	1.113287	1.093208	1.052075	0.920030	0.797218	0.534343	0.379715	0.219245	
0.139842	0.070495	0.040703	0.025807	0.009809	0.005692						
W50G35 West Valley (Wasatch 50) fault (dip 35)	USGS 2014 Utah	0.500000	0.446425	0.458604	0.531354						
0.663848	0.790941	1.006443	1.113881	1.089006	1.044361	0.908572	0.787251	0.527384	0.374166	0.214984	
0.137222	0.069515	0.040375	0.025500	0.009602	0.005560						
W35G35 West Valley (Wasatch 35) fault (dip 35)	USGS 2014 Utah	0.500000	0.443968	0.458142	0.535952						
0.674370	0.802738	1.011970	1.113549	1.082772	1.034205	0.894289	0.775467	0.519885	0.368183	0.210027	
0.134200	0.068403	0.039971	0.025112	0.009325	0.005372						

W65G50 West Valley (Wasatch 65) fault (dip 50) USGS 2014 Utah 0.500000 0.445121 0.459101 0.536617
0.673915 0.800636 1.009312 1.111846 1.082011 1.034439 0.894995 0.776464 0.520875 0.368919 0.210322
0.134282 0.068323 0.039759 0.025031 0.009320 0.005350
W50G50 West Valley (Wasatch 50) fault (dip 50) USGS 2014 Utah 0.500000 0.443368 0.458342 0.538485
0.679140 0.807067 1.013052 1.112060 1.078654 1.028550 0.886727 0.769126 0.515598 0.364704 0.207181
0.132310 0.067542 0.039479 0.024784 0.009167 0.005260
W35G50 West Valley (Wasatch 35) fault (dip 50) USGS 2014 Utah 0.500000 0.442318 0.456936 0.536518
0.676560 0.804900 1.014066 1.112774 1.077606 1.025752 0.882307 0.763088 0.508691 0.358911 0.203774
0.129719 0.066029 0.038615 0.024286 0.009045 0.005232
W50G65 West Valley (Wasatch 50) fault (dip 65) USGS 2014 Utah 0.500000 0.441390 0.457123 0.540260
0.683549 0.810671 1.015362 1.109608 1.070016 1.015328 0.868777 0.751412 0.500178 0.352482 0.198946
0.126547 0.064674 0.037902 0.023847 0.008849 0.005091
W65G65 West Valley (Wasatch 65) fault (dip 65) USGS 2014 Utah 0.500000 0.442316 0.458848 0.543868
0.688930 0.814963 1.014656 1.107725 1.068521 1.014720 0.868701 0.753817 0.504615 0.356648 0.201047
0.128350 0.065964 0.038683 0.024301 0.008936 0.005081
W35G65 West Valley (Wasatch 35) fault (dip 65) USGS 2014 Utah 0.500000 0.440723 0.455748 0.537170
0.678760 0.806675 1.015751 1.111218 1.071424 1.016090 0.869159 0.749746 0.496776 0.349333 0.197467
0.125262 0.063744 0.037348 0.023537 0.008803 0.005114
Great Salt Lake fault zone, Antelope Island [2369c] USGS 2014 Utah 0.500000 0.436604 0.448623 0.522463
0.651739 0.772044 0.992211 1.094199 1.059609 1.006724 0.870071 0.751410 0.497751 0.352325 0.206587
0.132613 0.070599 0.043876 0.028892 0.012123 0.007706
Great Salt Lake fault zone, Fremont Island s [2369b] USGS 2014 Utah 0.500000 0.432199 0.444141 0.518591
0.647799 0.769202 0.997508 1.097206 1.053883 0.993024 0.849967 0.728040 0.473160 0.331107 0.191755
0.121276 0.063411 0.038960 0.025614 0.010836 0.007032
Wasatch fault, Brigham City section [2351d] USGS 2014 Utah 0.500000 0.433324 0.446940 0.525509
0.658471 0.774850 0.982910 1.077088 1.038526 0.983507 0.848218 0.735293 0.488056 0.345342 0.201810
0.130066 0.070131 0.043954 0.029491 0.012577 0.008096
Oquirrh-Southern Oquirrh Mountains fault [2398_2399] USGS 2014 Utah 0.500000 0.430734 0.440241 0.506941
0.624937 0.740368 0.971904 1.083710 1.055845 1.007932 0.886855 0.770611 0.513923 0.365258 0.219409
0.142034 0.077219 0.049458 0.034155 0.016233 0.011578
East Cache fault zone [2352abc] USGS 2014 Utah 0.500000 0.430709 0.439157 0.502411
0.615586 0.728573 0.961295 1.078826 1.058491 1.016827 0.906213 0.792728 0.534698 0.382564 0.232968
0.152234 0.083955 0.054423 0.038001 0.018588 0.013545
Great Salt Lake fault zone, Promontory secti [2369a] USGS 2014 Utah 0.500000 0.426425 0.433039 0.490283
0.596933 0.717835 0.983046 1.114015 1.088625 1.040020 0.921132 0.795805 0.523780 0.368690 0.221150
0.140783 0.074180 0.046984 0.032552 0.016065 0.012075
Wasatch fault, Provo section [2351g] USGS 2014 Utah 0.500000 0.427446 0.433716 0.490129
0.594980 0.712210 0.971130 1.103761 1.085992 1.044499 0.937084 0.816957 0.546217 0.388011 0.235848
0.152085 0.081847 0.052577 0.036796 0.018533 0.014071
West Cache fault, Wellsville section [2521c] USGS 2014 Utah N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Stansbury fault zone [2395] USGS 2014 Utah N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Bear River fault zone [730] USGS 2014 Wyoming N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
West Cache fault zone, Junction Hills fault [2521b] USGS 2014 Utah N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Hansel Valley fault [2358] USGS 2014 Utah N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Eastern Bear Lake fault [2364abc] USGS 2014 Idaho N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
North Promontory fault [2361] USGS 2014 Nevada N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Strawberry fault [2412] USGS 2014 Utah N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Wasatch fault, Nephi section [2351h] USGS 2014 Utah N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
West Cache fault, Clarkston section [2521a] USGS 2014 Utah N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Rock Creek fault [729] USGS 2014 Wyoming N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Wasatch fault, Levan section [2351i] USGS 2014 Utah N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Joes Valley fault zone [2455] USGS 2014 Utah N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Grand Valley fault [726c] USGS 2014 Wyoming N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Greys River fault [728] USGS 2014 Wyoming N/A N/A N/A N/A
N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
N/A N/A N/A N/A N/A
Conditional Mean Spectrum (all sources) 0.500000 0.491078 0.491700 0.531814
0.622358 0.717013 0.884213 1.011513 1.076911 1.120009 1.116774 1.060024 0.862518 0.704151 0.489295
0.360920 0.218010 0.137210 0.092580 0.037882 0.020850

Deterministic Spectra Results using EZ-FRISK 8.07 Build 044

Largest Amplitudes of Ground Motions Considering All Sources Calculated using Weighted Mean of Attenuation Equations
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	2.543e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	3.767e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	4.759e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	4.451e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	4.977e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	5.420e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	5.107e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	4.913e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	4.448e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	4.119e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	3.299e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	2.781e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	2.297e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	1.946e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	1.427e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	1.149e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
3	8.724e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
4	6.550e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	5.317e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	2.363e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	1.329e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	1.657e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	2.465e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	3.100e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	2.901e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	3.230e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	3.507e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	3.305e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	3.180e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	2.881e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	2.670e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	2.134e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	1.796e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	1.474e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	1.240e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	9.081e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	7.368e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
3	5.575e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
4	4.167e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	3.389e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	1.506e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	8.471e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Largest Amplitudes of Ground Motions Considering Sources Calculated with Frankel (1996) USGS 2008 Truncated Mw
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	7.136e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	8.109e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	8.739e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	9.602e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	1.035e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	1.091e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	1.176e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	1.240e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	1.079e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	9.626e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	7.721e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	6.508e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	5.842e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	5.412e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	3.711e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	2.840e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	1.922e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	1.457e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	1.165e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	5.179e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	2.913e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	4.483e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	5.095e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	5.491e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

0.05	6.033e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	6.502e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	6.856e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	7.389e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	7.791e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	6.777e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	6.048e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	4.851e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	4.089e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	3.647e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	3.364e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	2.307e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	1.766e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	1.195e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	9.055e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	7.244e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	3.220e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	1.811e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Largest Amplitudes of Ground Motions Considering Sources Calculated with Toro (1999) Midcontinent - USGS 2008 Mw
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	3.087e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	3.803e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	4.297e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	5.011e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	5.661e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	6.174e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	6.174e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	6.174e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	6.174e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	6.174e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	4.965e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	4.194e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	3.924e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	3.743e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	2.702e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	2.144e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	1.429e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	1.072e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	8.575e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	3.811e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	2.144e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	1.939e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	2.389e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	2.700e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	3.148e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	3.557e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	3.879e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	3.879e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	3.879e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	3.879e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	3.879e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	3.120e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	2.635e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	2.449e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	2.327e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	1.679e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	1.333e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	8.885e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	6.664e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	5.331e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	2.369e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	1.333e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Largest Amplitudes of Ground Motions Considering Sources Calculated with Silva et al (2002) USGS 2008 Mw
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	5.925e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	7.651e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	8.886e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	1.073e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	1.246e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	1.386e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	1.163e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	1.027e+001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	8.650e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	7.521e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

0.4	6.155e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	5.270e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	4.716e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	4.359e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	3.835e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	3.502e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	2.698e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	2.243e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	1.943e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	8.638e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	4.859e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	3.653e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	4.716e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	5.476e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	6.610e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	7.675e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	8.533e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	7.173e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	6.342e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	5.340e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	4.640e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	3.796e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	3.248e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	2.900e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	2.676e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	2.340e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	2.136e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	1.656e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	1.390e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	1.217e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	5.410e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	3.043e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Largest Amplitudes of Ground Motions Considering Sources Calculated with Campbell (2003) USGS 2008 Mw

Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	2.338e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	4.675e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	4.675e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	4.799e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	4.649e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	4.624e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	4.493e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	4.323e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	3.981e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	3.721e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	3.146e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	2.761e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	2.788e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	2.280e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	1.535e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	1.137e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	6.759e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	4.394e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	3.515e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	1.562e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	8.789e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	1.635e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	3.270e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	3.270e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	3.312e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	3.261e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	3.253e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	3.146e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	3.012e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	2.771e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	2.588e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	2.172e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	1.895e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	1.896e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	1.539e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	1.035e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	7.654e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	4.527e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	2.927e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	2.341e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	1.041e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	5.853e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Largest Amplitudes of Ground Motions Considering Sources Calculated with Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	2.437e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	3.328e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	3.993e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	5.023e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	4.761e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	5.074e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	4.856e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	4.785e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	4.811e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	5.119e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	3.770e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	3.110e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	2.137e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	1.467e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	1.327e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	8.601e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	3.850e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	1.053e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	8.428e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	3.746e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	2.107e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	1.689e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	2.292e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	2.740e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	3.432e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	3.342e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	3.450e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	3.374e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	3.350e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	3.359e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	3.444e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	2.607e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	2.138e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	1.457e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	9.936e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	8.931e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	5.760e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	2.567e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	6.976e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	5.581e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	2.480e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	1.395e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Largest Amplitudes of Ground Motions Considering Sources Calculated with Atkinson-Boore (2006p) USGS 2014 Table Soil
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	1.854e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	4.074e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	5.783e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	3.674e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	4.114e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	4.458e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	3.767e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	3.351e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	2.788e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	2.400e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	1.912e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	1.604e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	1.019e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	7.433e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	4.615e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	3.267e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	2.105e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	1.574e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	1.256e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	5.584e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	3.141e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	1.184e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	2.602e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	3.693e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

0.05	2.347e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	2.628e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	2.847e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	2.406e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	2.140e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	1.781e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	1.533e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	1.221e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	1.024e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	6.507e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	4.747e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	2.947e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	2.087e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	1.344e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	1.005e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	8.025e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	3.567e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	2.006e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Largest Amplitudes of Ground Motions Considering Sources Calculated with Pezeshk et al (2011) USGS 2014 Table Soil
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	1.467e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	1.593e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	2.363e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	1.756e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	2.514e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	3.288e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	3.355e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	3.404e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	3.091e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	2.857e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	2.358e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	2.049e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	1.401e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	1.070e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	6.538e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	4.576e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	2.975e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	2.042e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	1.526e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	6.781e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	3.814e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	9.307e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	1.011e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	1.500e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	1.114e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	1.599e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	2.092e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	2.134e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	2.165e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	1.966e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	1.818e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	1.504e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	1.306e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	8.935e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	6.824e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	4.169e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	2.918e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	1.897e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	1.302e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	9.729e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	4.324e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	2.432e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Largest Amplitudes of Ground Motions Considering Sources Calculated with Atkinson (2008p) USGS 2014 Table Soil
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	1.820e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	2.378e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	5.303e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	3.549e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	4.105e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	4.551e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	3.983e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	3.624e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	2.827e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	2.452e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

0.4	1.656e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	1.298e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	8.250e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	6.356e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	4.895e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	4.066e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	4.399e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	3.445e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	2.826e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	1.256e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	7.065e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	1.163e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.02	1.519e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.03	3.387e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.05	2.267e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.075	2.622e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.1	2.907e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.15	2.544e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.2	2.314e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.25	1.806e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.3	1.566e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.4	1.058e+000	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.5	8.288e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
0.75	5.269e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1	4.059e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
1.5	3.126e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
2	2.597e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
3	2.809e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
4	2.200e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
5	1.805e-001	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
7.5	8.021e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source
10	4.512e-002	8.00 Mw	5.00	USGS 2014 CEUS Gridded Source	CEUS Gridded Source

Largest Amplitudes of Ground Motions Considering Sources Calculated with Abrahamson-et al (2014) NGA West 2 USGS 2014
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	9.169e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.02	9.025e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.03	8.330e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.05	8.345e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.075	9.517e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.1	1.115e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.15	1.490e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.2	1.742e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.25	1.920e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.3	2.117e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.4	2.384e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.5	2.242e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.75	1.773e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1	1.514e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1.5	1.200e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
2	1.027e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
3	7.629e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
4	5.502e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
5	4.364e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
7.5	2.226e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
10	1.380e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	6.395e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.02	6.309e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.03	5.862e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.05	5.888e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.075	6.708e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.1	7.873e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.15	1.061e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.2	1.244e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.25	1.367e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.3	1.496e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.4	1.654e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.5	1.543e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.75	1.206e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1	1.015e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1.5	7.867e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
2	6.614e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
3	4.890e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
4	3.537e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
5	2.803e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
7.5	1.427e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
10	8.821e-002	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model

Largest Amplitudes of Ground Motions Considering Sources Calculated with Boore-et al (2014) NGA West 2 USGS 2014
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	9.610e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.02	9.481e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.03	9.519e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.05	1.052e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.075	1.286e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.1	1.451e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.15	1.678e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.2	1.815e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.25	1.874e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.3	1.968e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.4	2.017e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.5	2.123e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.75	1.881e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
1	1.759e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
1.5	1.471e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
2	1.311e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
3	1.006e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
4	7.950e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
5	6.366e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
7.5	3.443e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
10	2.101e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	6.469e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.02	6.361e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.03	6.336e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.05	6.850e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.075	8.246e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.1	9.318e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.15	1.100e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.2	1.216e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.25	1.265e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.3	1.333e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.4	1.361e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.5	1.415e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
0.75	1.232e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
1	1.144e+000	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
1.5	9.553e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
2	8.483e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
3	6.469e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
4	5.091e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
5	4.075e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
7.5	2.218e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
10	1.369e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded

Largest Amplitudes of Ground Motions Considering Sources Calculated with Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	7.017e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.02	7.360e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.03	7.675e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.05	8.636e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.075	9.781e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.1	1.098e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.15	1.111e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.2	1.243e+000	6.52 Mw	11.40	USGS 2014 Utah	Morgan fault [2353abc]
0.25	1.338e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.3	1.546e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.4	1.818e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.5	1.941e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.75	2.147e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1	1.883e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1.5	1.580e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
2	1.432e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
3	1.056e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
4	6.772e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
5	4.816e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
7.5	2.104e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source	Shallow - Extensional Gridded
10	1.180e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	5.049e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.02	5.293e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.03	5.508e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model

0.05	6.142e-001	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
0.075	6.838e-001	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
0.1	7.651e-001	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
0.15	7.859e-001	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
0.2	8.781e-001	6.52 Mw	11.40	USGS 2014 Utah		Morgan fault [2353abc]
0.25	9.499e-001	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
0.3	1.080e+000	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
0.4	1.241e+000	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
0.5	1.300e+000	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
0.75	1.392e+000	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
1	1.208e+000	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
1.5	1.006e+000	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
2	9.107e-001	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
3	6.702e-001	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
4	4.335e-001	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model
5	3.073e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source		Shallow - Extensional Gridded
7.5	1.340e-001	8.00 Mw	5.00	USGS 2014 WUS Gridded Source		Shallow - Extensional Gridded
10	7.524e-002	7.40 Mw	0.76	USGS 2014 Utah		Salt Lake City - Wasatch Fault Source Model

Largest Amplitudes of Ground Motions Considering Sources Calculated with Chiou-Youngs (2014) NGA West 2 USGS 2014
Amplitude Units: Acceleration (g)

Fractile: 0.84

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	9.759e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.02	9.847e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.03	9.831e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.05	1.015e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.075	1.134e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.1	1.268e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.15	1.488e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.2	1.759e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.25	2.012e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.3	2.200e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.4	2.417e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.5	2.545e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.75	2.432e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1	2.159e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1.5	1.573e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
2	1.348e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
3	9.392e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
4	6.156e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
5	4.046e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
7.5	1.727e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
10	9.288e-002	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model

Fractile: Mean

Period	Amplitude	Magnitude	Closest Distance(km)	Region	Controlling Source
PGA	6.880e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.02	6.934e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.03	6.899e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.05	7.148e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.075	8.071e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.1	9.074e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.15	1.065e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.2	1.252e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.25	1.420e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.3	1.541e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.4	1.671e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.5	1.738e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
0.75	1.622e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1	1.419e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
1.5	1.017e+000	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
2	8.650e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
3	6.008e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
4	3.937e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
5	2.589e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
7.5	1.108e-001	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model
10	5.964e-002	7.40 Mw	0.76	USGS 2014 Utah	Salt Lake City - Wasatch Fault Source Model

Largest Amplitudes of Ground Motions for Each Source

Source: CEUS Gridded Source
Region: USGS 2014 CEUS Gridded Source
Closest Distance: 5.00 km
Amplitude Units: Acceleration (g)
Magnitude: 8.00 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Frankel (1996) USGS 2008 Truncated Mw
Column 4: Acceleration (g) for: Toro (1999) Midcontinent - USGS 2008 Mw
Column 5: Acceleration (g) for: Silva et al (2002) USGS 2008 Mw
Column 6: Acceleration (g) for: Campbell (2003) USGS 2008 Mw
Column 7: Acceleration (g) for: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw

Column 8: Acceleration (g) for: Atkinson-Boore (2006p) USGS 2014 Table Soil
Column 9: Acceleration (g) for: Pezeshk et al (2011) USGS 2014 Table Soil
Column 10: Acceleration (g) for: Atkinson (2008p) USGS 2014 Table Soil

1	2	3	4	5	6	7	8	9	10
PGA	2.543e+000	7.136e+000	3.087e+000	5.925e+000	2.338e+000	2.437e+000	1.854e+000	1.467e+000	1.820e+000
0.02	3.767e+000	8.109e+000	3.803e+000	7.651e+000	4.675e+000	3.328e+000	4.074e+000	1.593e+000	2.378e+000
0.03	4.759e+000	8.739e+000	4.297e+000	8.886e+000	4.675e+000	3.993e+000	5.783e+000	2.363e+000	5.303e+000
0.05	4.451e+000	9.602e+000	5.011e+000	1.073e+001	4.799e+000	5.023e+000	3.674e+000	1.756e+000	3.549e+000
0.075	4.977e+000	1.035e+001	5.661e+000	1.246e+001	4.649e+000	4.761e+000	4.114e+000	2.514e+000	4.105e+000
0.1	5.420e+000	1.091e+001	6.174e+000	1.386e+001	4.624e+000	5.074e+000	4.458e+000	3.288e+000	4.551e+000
0.15	5.107e+000	1.176e+001	6.174e+000	1.163e+001	4.493e+000	4.856e+000	3.767e+000	3.355e+000	3.983e+000
0.2	4.913e+000	1.240e+001	6.174e+000	1.027e+001	4.323e+000	4.785e+000	3.351e+000	3.404e+000	3.624e+000
0.25	4.448e+000	1.079e+001	6.174e+000	8.650e+000	3.981e+000	4.811e+000	2.788e+000	3.091e+000	2.827e+000
0.3	4.119e+000	9.626e+000	6.174e+000	7.521e+000	3.721e+000	5.119e+000	2.400e+000	2.857e+000	2.452e+000
0.4	3.299e+000	7.721e+000	4.965e+000	6.155e+000	3.146e+000	3.770e+000	1.912e+000	2.358e+000	1.656e+000
0.5	2.781e+000	6.508e+000	4.194e+000	5.270e+000	2.761e+000	3.110e+000	1.604e+000	2.049e+000	1.298e+000
0.75	2.297e+000	5.842e+000	3.924e+000	4.716e+000	2.788e+000	2.137e+000	1.019e+000	1.401e+000	8.250e-001
1	1.946e+000	5.412e+000	3.743e+000	4.359e+000	2.280e+000	1.467e+000	7.433e-001	1.070e+000	6.356e-001
1.5	1.427e+000	3.711e+000	2.702e+000	3.835e+000	1.535e+000	1.327e+000	4.615e-001	6.538e-001	4.895e-001
2	1.104e+000	2.840e+000	2.144e+000	3.502e+000	1.137e+000	8.601e-001	3.267e-001	4.576e-001	4.066e-001
3	7.363e-001	1.922e+000	1.429e+000	2.698e+000	6.759e-001	3.850e-001	2.105e-001	2.975e-001	4.399e-001
4	6.550e-001	1.457e+000	1.072e+000	2.243e+000	4.394e-001	1.053e+000	1.574e-001	2.042e-001	3.445e-001
5	5.317e-001	1.165e+000	8.575e-001	1.943e+000	3.515e-001	8.428e-001	1.256e-001	1.526e-001	2.826e-001
7.5	2.363e-001	5.179e-001	3.811e-001	8.638e-001	1.562e-001	3.746e-001	5.584e-002	6.781e-002	1.256e-001
10	1.329e-001	2.913e-001	2.144e-001	4.859e-001	8.789e-002	2.107e-001	3.141e-002	3.814e-002	7.065e-002

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Frankel (1996) USGS 2008 Truncated Mw
Column 4: Acceleration (g) for: Toro (1999) Midcontinent - USGS 2008 Mw
Column 5: Acceleration (g) for: Silva et al (2002) USGS 2008 Mw
Column 6: Acceleration (g) for: Campbell (2003) USGS 2008 Mw
Column 7: Acceleration (g) for: Tavakoli-Pezeshk (2005) ENA USGS 2008 Mw
Column 8: Acceleration (g) for: Atkinson-Boore (2006p) USGS 2014 Table Soil
Column 9: Acceleration (g) for: Pezeshk et al (2011) USGS 2014 Table Soil
Column 10: Acceleration (g) for: Atkinson (2008p) USGS 2014 Table Soil

1	2	3	4	5	6	7	8	9	10
PGA	1.657e+000	4.483e+000	1.939e+000	3.653e+000	1.635e+000	1.689e+000	1.184e+000	9.307e-001	1.163e+000
0.02	2.465e+000	5.095e+000	2.389e+000	4.716e+000	3.270e+000	2.292e+000	2.602e+000	1.011e+000	1.519e+000
0.03	3.100e+000	5.491e+000	2.700e+000	5.476e+000	3.270e+000	2.740e+000	3.693e+000	1.500e+000	3.387e+000
0.05	2.901e+000	6.033e+000	3.148e+000	6.610e+000	3.312e+000	3.432e+000	2.347e+000	1.114e+000	2.267e+000
0.075	3.230e+000	6.502e+000	3.557e+000	7.675e+000	3.261e+000	3.342e+000	2.628e+000	1.599e+000	2.622e+000
0.1	3.507e+000	6.856e+000	3.879e+000	8.533e+000	3.253e+000	3.450e+000	2.847e+000	2.092e+000	2.907e+000
0.15	3.305e+000	7.389e+000	3.879e+000	7.173e+000	3.146e+000	3.374e+000	2.406e+000	2.134e+000	2.544e+000
0.2	3.180e+000	7.791e+000	3.879e+000	6.342e+000	3.012e+000	3.350e+000	2.140e+000	2.165e+000	2.314e+000
0.25	2.881e+000	6.777e+000	3.879e+000	5.340e+000	2.771e+000	3.359e+000	1.781e+000	1.966e+000	1.806e+000
0.3	2.670e+000	6.048e+000	3.879e+000	4.640e+000	2.588e+000	3.444e+000	1.533e+000	1.818e+000	1.566e+000
0.4	2.134e+000	4.851e+000	3.120e+000	3.796e+000	2.172e+000	2.607e+000	1.221e+000	1.504e+000	1.058e+000
0.5	1.796e+000	4.089e+000	2.635e+000	3.248e+000	1.895e+000	2.138e+000	1.024e+000	1.306e+000	8.288e-001
0.75	1.474e+000	3.647e+000	2.449e+000	2.900e+000	1.896e+000	1.457e+000	6.507e-001	8.935e-001	5.269e-001

1	1.240e+000	3.364e+000	2.327e+000	2.676e+000	1.539e+000	9.936e-001	4.747e-001	6.824e-001
4.059e-001								
1.5	9.081e-001	2.307e+000	1.679e+000	2.340e+000	1.035e+000	8.931e-001	2.947e-001	4.169e-001
3.126e-001								
2	6.997e-001	1.766e+000	1.333e+000	2.136e+000	7.654e-001	5.760e-001	2.087e-001	2.918e-001
2.597e-001								
3	4.652e-001	1.195e+000	8.885e-001	1.656e+000	4.527e-001	2.567e-001	1.344e-001	1.897e-001
2.809e-001								
4	4.167e-001	9.055e-001	6.664e-001	1.390e+000	2.927e-001	6.976e-001	1.005e-001	1.302e-001
2.200e-001								
5	3.389e-001	7.244e-001	5.331e-001	1.217e+000	2.341e-001	5.581e-001	8.025e-002	9.729e-002
1.805e-001								
7.5	1.506e-001	3.220e-001	2.369e-001	5.410e-001	1.041e-001	2.480e-001	3.567e-002	4.324e-002
8.021e-002								
10	8.471e-002	1.811e-001	1.333e-001	3.043e-001	5.853e-002	1.395e-001	2.006e-002	2.432e-002
4.512e-002								

Source: Shallow - Extensional Gridded
Region: USGS 2014 WUS Gridded Source
  Closest Distance: 5.00 km
  Amplitude Units: Acceleration (g)
  Magnitude: 8.00 Mw
  Fractile: 0.84
  Column 1: Spectral Period
  Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
  Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
  Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
  Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	8.187e-001	8.397e-001	9.610e-001	5.555e-001	9.185e-001
0.02	8.182e-001	8.285e-001	9.481e-001	5.727e-001	9.233e-001
0.03	8.076e-001	7.707e-001	9.519e-001	5.906e-001	9.171e-001
0.05	8.593e-001	7.747e-001	1.052e+000	6.681e-001	9.421e-001
0.075	1.003e+000	8.814e-001	1.286e+000	7.894e-001	1.056e+000
0.1	1.137e+000	1.035e+000	1.451e+000	8.731e-001	1.189e+000
0.15	1.356e+000	1.402e+000	1.678e+000	9.386e-001	1.411e+000
0.2	1.530e+000	1.652e+000	1.815e+000	9.796e-001	1.676e+000
0.25	1.679e+000	1.822e+000	1.874e+000	1.100e+000	1.921e+000
0.3	1.814e+000	1.987e+000	1.968e+000	1.211e+000	2.091e+000
0.4	1.989e+000	2.199e+000	2.017e+000	1.445e+000	2.295e+000
0.5	2.036e+000	2.063e+000	2.123e+000	1.538e+000	2.421e+000
0.75	1.831e+000	1.633e+000	1.881e+000	1.464e+000	2.348e+000
1	1.667e+000	1.389e+000	1.759e+000	1.426e+000	2.095e+000
1.5	1.353e+000	1.112e+000	1.471e+000	1.285e+000	1.544e+000
2	1.135e+000	8.799e-001	1.311e+000	1.133e+000	1.217e+000
3	7.995e-001	6.013e-001	1.006e+000	8.747e-001	7.154e-001
4	5.812e-001	4.473e-001	7.950e-001	6.360e-001	4.465e-001
5	4.387e-001	3.453e-001	6.366e-001	4.816e-001	2.913e-001
7.5	2.202e-001	1.971e-001	3.443e-001	2.104e-001	1.289e-001
10	1.270e-001	1.225e-001	2.101e-001	1.045e-001	7.102e-002

  Fractile: Mean
  Column 1: Spectral Period
  Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
  Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
  Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
  Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
  Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	5.684e-001	5.833e-001	6.469e-001	3.964e-001	6.470e-001
0.02	5.678e-001	5.769e-001	6.361e-001	4.084e-001	6.496e-001
0.03	5.594e-001	5.405e-001	6.336e-001	4.203e-001	6.430e-001
0.05	5.913e-001	5.454e-001	6.850e-001	4.719e-001	6.629e-001
0.075	6.860e-001	6.208e-001	8.246e-001	5.487e-001	7.500e-001
0.1	7.789e-001	7.304e-001	9.318e-001	6.048e-001	8.495e-001
0.15	9.400e-001	9.982e-001	1.100e+000	6.588e-001	1.009e+000
0.2	1.068e+000	1.178e+000	1.216e+000	6.904e-001	1.190e+000
0.25	1.172e+000	1.295e+000	1.265e+000	7.745e-001	1.354e+000
0.3	1.259e+000	1.400e+000	1.333e+000	8.393e-001	1.463e+000
0.4	1.361e+000	1.519e+000	1.361e+000	9.801e-001	1.584e+000
0.5	1.377e+000	1.414e+000	1.415e+000	1.025e+000	1.652e+000
0.75	1.213e+000	1.106e+000	1.232e+000	9.465e-001	1.565e+000
1	1.091e+000	9.278e-001	1.144e+000	9.134e-001	1.377e+000
1.5	8.748e-001	7.281e-001	9.553e-001	8.171e-001	9.984e-001
2	7.290e-001	5.664e-001	8.483e-001	7.203e-001	7.812e-001
3	5.113e-001	3.854e-001	6.469e-001	5.551e-001	4.576e-001
4	3.723e-001	2.876e-001	5.091e-001	4.072e-001	2.855e-001
5	2.808e-001	2.218e-001	4.075e-001	3.073e-001	1.864e-001
7.5	1.412e-001	1.264e-001	2.218e-001	1.340e-001	8.267e-002
10	8.184e-002	7.830e-002	1.369e-001	6.658e-002	4.560e-002

Source: Wasatch fault, Weber section [2351e]
Region: USGS 2014 Utah

Closest Distance: 0.73 km
Amplitude Units: Acceleration (g)
Magnitude: 7.16 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	7.945e-001	8.754e-001	7.515e-001	6.541e-001	8.970e-001
0.02	8.026e-001	8.629e-001	7.541e-001	6.888e-001	9.045e-001
0.03	8.009e-001	7.999e-001	7.805e-001	7.188e-001	9.044e-001
0.05	8.636e-001	8.030e-001	9.065e-001	8.065e-001	9.385e-001
0.075	9.969e-001	9.155e-001	1.099e+000	9.144e-001	1.059e+000
0.1	1.124e+000	1.074e+000	1.202e+000	1.027e+000	1.192e+000
0.15	1.325e+000	1.442e+000	1.396e+000	1.052e+000	1.409e+000
0.2	1.514e+000	1.687e+000	1.563e+000	1.131e+000	1.673e+000
0.25	1.658e+000	1.851e+000	1.606e+000	1.261e+000	1.913e+000
0.3	1.799e+000	2.026e+000	1.641e+000	1.448e+000	2.082e+000
0.4	1.941e+000	2.247e+000	1.572e+000	1.670e+000	2.275e+000
0.5	1.952e+000	2.101e+000	1.562e+000	1.752e+000	2.395e+000
0.75	1.780e+000	1.641e+000	1.299e+000	1.876e+000	2.305e+000
1	1.551e+000	1.388e+000	1.140e+000	1.621e+000	2.054e+000
1.5	1.180e+000	1.090e+000	8.239e-001	1.315e+000	1.490e+000
2	1.031e+000	9.336e-001	7.428e-001	1.179e+000	1.267e+000
3	7.657e-001	6.857e-001	6.057e-001	9.024e-001	8.689e-001
4	5.135e-001	4.899e-001	4.426e-001	5.634e-001	5.580e-001
5	3.611e-001	3.839e-001	3.148e-001	3.866e-001	3.591e-001
7.5	1.548e-001	1.915e-001	1.202e-001	1.600e-001	1.474e-001
10	8.779e-002	1.134e-001	6.234e-002	9.850e-002	7.689e-002

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	5.541e-001	6.093e-001	5.059e-001	4.697e-001	6.317e-001
0.02	5.596e-001	6.020e-001	5.060e-001	4.943e-001	6.362e-001
0.03	5.576e-001	5.619e-001	5.195e-001	5.149e-001	6.340e-001
0.05	5.973e-001	5.660e-001	5.901e-001	5.727e-001	6.604e-001
0.075	6.852e-001	6.452e-001	7.047e-001	6.385e-001	7.522e-001
0.1	7.742e-001	7.586e-001	7.718e-001	7.151e-001	8.513e-001
0.15	9.229e-001	1.027e+000	9.146e-001	7.433e-001	1.007e+000
0.2	1.060e+000	1.204e+000	1.047e+000	8.029e-001	1.188e+000
0.25	1.161e+000	1.317e+000	1.084e+000	8.938e-001	1.349e+000
0.3	1.252e+000	1.429e+000	1.112e+000	1.010e+000	1.457e+000
0.4	1.331e+000	1.554e+000	1.061e+000	1.138e+000	1.570e+000
0.5	1.322e+000	1.441e+000	1.041e+000	1.172e+000	1.634e+000
0.75	1.179e+000	1.112e+000	8.511e-001	1.216e+000	1.536e+000
1	1.014e+000	9.267e-001	7.415e-001	1.039e+000	1.350e+000
1.5	7.621e-001	7.135e-001	5.352e-001	8.363e-001	9.636e-001
2	6.611e-001	6.008e-001	4.806e-001	7.498e-001	8.133e-001
3	4.893e-001	4.395e-001	3.893e-001	5.727e-001	5.558e-001
4	3.290e-001	3.150e-001	2.834e-001	3.606e-001	3.569e-001
5	2.312e-001	2.466e-001	2.015e-001	2.467e-001	2.298e-001
7.5	9.918e-002	1.228e-001	7.746e-002	1.019e-001	9.455e-002
10	5.633e-002	7.254e-002	4.062e-002	6.278e-002	4.938e-002

Source: Salt Lake City - Wasatch Fault Source Model
Region: USGS 2014 Utah
Closest Distance: 0.76 km
Amplitude Units: Acceleration (g)
Magnitude: 7.40 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	8.406e-001	9.169e-001	7.678e-001	7.017e-001	9.759e-001
0.02	8.483e-001	9.025e-001	7.698e-001	7.360e-001	9.847e-001
0.03	8.448e-001	8.330e-001	7.957e-001	7.675e-001	9.831e-001
0.05	9.074e-001	8.345e-001	9.169e-001	8.636e-001	1.015e+000
0.075	1.042e+000	9.517e-001	1.103e+000	9.781e-001	1.134e+000
0.1	1.171e+000	1.115e+000	1.202e+000	1.098e+000	1.268e+000
0.15	1.371e+000	1.490e+000	1.395e+000	1.111e+000	1.488e+000
0.2	1.569e+000	1.742e+000	1.568e+000	1.208e+000	1.759e+000
0.25	1.723e+000	1.920e+000	1.622e+000	1.338e+000	2.012e+000

0.3	1.883e+000	2.117e+000	1.670e+000	1.546e+000	2.200e+000
0.4	2.061e+000	2.384e+000	1.625e+000	1.818e+000	2.417e+000
0.5	2.091e+000	2.242e+000	1.635e+000	1.941e+000	2.545e+000
0.75	1.934e+000	1.773e+000	1.384e+000	2.147e+000	2.432e+000
1	1.698e+000	1.514e+000	1.234e+000	1.883e+000	2.159e+000
1.5	1.313e+000	1.200e+000	9.290e-001	1.580e+000	1.573e+000
2	1.149e+000	1.027e+000	8.631e-001	1.432e+000	1.348e+000
3	8.724e-001	7.629e-001	7.368e-001	1.056e+000	9.392e-001
4	6.003e-001	5.502e-001	5.583e-001	6.772e-001	6.156e-001
5	4.304e-001	4.364e-001	4.086e-001	4.722e-001	4.046e-001
7.5	1.896e-001	2.226e-001	1.641e-001	1.991e-001	1.727e-001
10	1.091e-001	1.380e-001	8.748e-002	1.180e-001	9.288e-002

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	5.873e-001	6.395e-001	5.168e-001	5.049e-001	6.880e-001
0.02	5.925e-001	6.309e-001	5.165e-001	5.293e-001	6.934e-001
0.03	5.892e-001	5.862e-001	5.296e-001	5.508e-001	6.899e-001
0.05	6.286e-001	5.888e-001	5.968e-001	6.142e-001	7.148e-001
0.075	7.173e-001	6.708e-001	7.074e-001	6.838e-001	8.071e-001
0.1	8.079e-001	7.873e-001	7.718e-001	7.651e-001	9.074e-001
0.15	9.565e-001	1.061e+000	9.139e-001	7.859e-001	1.065e+000
0.2	1.101e+000	1.244e+000	1.051e+000	8.587e-001	1.252e+000
0.25	1.208e+000	1.367e+000	1.095e+000	9.499e-001	1.420e+000
0.3	1.312e+000	1.496e+000	1.132e+000	1.080e+000	1.541e+000
0.4	1.415e+000	1.654e+000	1.097e+000	1.241e+000	1.671e+000
0.5	1.418e+000	1.543e+000	1.090e+000	1.300e+000	1.738e+000
0.75	1.282e+000	1.206e+000	9.068e-001	1.392e+000	1.622e+000
1	1.111e+000	1.015e+000	8.028e-001	1.208e+000	1.419e+000
1.5	8.484e-001	7.867e-001	6.034e-001	1.006e+000	1.017e+000
2	7.368e-001	6.614e-001	5.584e-001	9.107e-001	8.650e-001
3	5.575e-001	4.890e-001	4.736e-001	6.702e-001	6.008e-001
4	3.846e-001	3.537e-001	3.575e-001	4.335e-001	3.937e-001
5	2.755e-001	2.803e-001	2.616e-001	3.013e-001	2.589e-001
7.5	1.215e-001	1.427e-001	1.057e-001	1.268e-001	1.108e-001
10	7.003e-002	8.821e-002	5.701e-002	7.524e-002	5.964e-002

Source: Morgan fault [2353abc]
Region: USGS 2014 Utah
Closest Distance: 11.40 km
Amplitude Units: Acceleration (g)
Magnitude: 6.52 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	6.307e-001	6.787e-001	7.098e-001	5.801e-001	5.957e-001
0.02	6.360e-001	6.736e-001	7.137e-001	5.934e-001	6.034e-001
0.03	6.438e-001	6.383e-001	7.413e-001	6.108e-001	6.192e-001
0.05	7.208e-001	6.500e-001	8.793e-001	7.063e-001	6.795e-001
0.075	8.589e-001	7.404e-001	1.088e+000	8.341e-001	8.080e-001
0.1	9.951e-001	8.750e-001	1.201e+000	1.018e+000	9.253e-001
0.15	1.179e+000	1.203e+000	1.398e+000	1.072e+000	1.091e+000
0.2	1.351e+000	1.411e+000	1.548e+000	1.243e+000	1.256e+000
0.25	1.428e+000	1.523e+000	1.563e+000	1.307e+000	1.383e+000
0.3	1.500e+000	1.605e+000	1.564e+000	1.465e+000	1.435e+000
0.4	1.507e+000	1.634e+000	1.439e+000	1.596e+000	1.437e+000
0.5	1.439e+000	1.458e+000	1.382e+000	1.589e+000	1.392e+000
0.75	1.211e+000	1.026e+000	1.098e+000	1.632e+000	1.123e+000
1	9.102e-001	7.861e-001	9.228e-001	1.058e+000	8.945e-001
1.5	5.988e-001	5.201e-001	5.990e-001	7.291e-001	5.553e-001
2	4.458e-001	3.566e-001	4.709e-001	5.751e-001	3.929e-001
3	2.436e-001	1.804e-001	3.076e-001	3.039e-001	1.872e-001
4	1.373e-001	9.523e-002	1.924e-001	1.668e-001	9.600e-002
5	8.552e-002	6.629e-002	1.222e-001	9.943e-002	5.442e-002
7.5	3.201e-002	3.118e-002	3.985e-002	3.880e-002	1.905e-002
10	1.674e-002	1.815e-002	1.874e-002	2.194e-002	8.841e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	4.361e-001	4.647e-001	4.778e-001	4.147e-001	4.170e-001
0.02	4.395e-001	4.623e-001	4.789e-001	4.240e-001	4.218e-001
0.03	4.442e-001	4.416e-001	4.934e-001	4.356e-001	4.315e-001
0.05	4.942e-001	4.527e-001	5.724e-001	4.998e-001	4.752e-001
0.075	5.851e-001	5.176e-001	6.976e-001	5.806e-001	5.700e-001
0.1	6.795e-001	6.138e-001	7.713e-001	7.059e-001	6.553e-001
0.15	8.141e-001	8.495e-001	9.160e-001	7.545e-001	7.716e-001
0.2	9.378e-001	9.964e-001	1.037e+000	8.781e-001	8.816e-001
0.25	9.899e-001	1.069e+000	1.055e+000	9.220e-001	9.633e-001
0.3	1.032e+000	1.113e+000	1.060e+000	1.017e+000	9.916e-001
0.4	1.022e+000	1.108e+000	9.713e-001	1.084e+000	9.794e-001
0.5	9.637e-001	9.795e-001	9.217e-001	1.060e+000	9.385e-001
0.75	7.932e-001	6.794e-001	7.191e-001	1.056e+000	7.422e-001
1	5.906e-001	5.137e-001	6.003e-001	6.776e-001	5.842e-001
1.5	3.851e-001	3.352e-001	3.891e-001	4.636e-001	3.579e-001
2	2.855e-001	2.276e-001	3.047e-001	3.656e-001	2.518e-001
3	1.556e-001	1.151e-001	1.977e-001	1.929e-001	1.197e-001
4	8.788e-002	6.094e-002	1.232e-001	1.068e-001	6.139e-002
5	5.469e-002	4.239e-002	7.822e-002	6.345e-002	3.483e-002
7.5	2.049e-002	1.990e-002	2.567e-002	2.472e-002	1.221e-002
10	1.075e-002	1.156e-002	1.221e-002	1.398e-002	5.677e-003

Source: West Valley fault [2386]
Region: USGS 2014 Utah
Closest Distance: 18.84 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.942e-001	3.496e-001	3.089e-001	2.633e-001	2.550e-001
0.02	2.960e-001	3.520e-001	3.081e-001	2.674e-001	2.566e-001
0.03	3.031e-001	3.502e-001	3.214e-001	2.747e-001	2.659e-001
0.05	3.454e-001	3.779e-001	3.805e-001	3.190e-001	3.040e-001
0.075	4.273e-001	4.470e-001	4.750e-001	4.039e-001	3.831e-001
0.1	5.137e-001	5.428e-001	5.453e-001	5.075e-001	4.591e-001
0.15	6.500e-001	7.695e-001	6.670e-001	6.030e-001	5.605e-001
0.2	7.414e-001	8.919e-001	7.516e-001	6.813e-001	6.408e-001
0.25	7.739e-001	9.228e-001	7.625e-001	7.187e-001	6.916e-001
0.3	7.833e-001	9.211e-001	7.536e-001	7.532e-001	7.054e-001
0.4	7.415e-001	8.596e-001	6.776e-001	7.455e-001	6.835e-001
0.5	6.849e-001	7.570e-001	6.314e-001	7.064e-001	6.448e-001
0.75	5.285e-001	5.250e-001	4.834e-001	5.984e-001	5.072e-001
1	4.081e-001	3.962e-001	3.820e-001	4.571e-001	3.971e-001
1.5	2.663e-001	2.645e-001	2.378e-001	3.115e-001	2.513e-001
2	2.015e-001	1.884e-001	1.824e-001	2.509e-001	1.843e-001
3	1.239e-001	1.062e-001	1.235e-001	1.608e-001	1.052e-001
4	7.653e-002	6.342e-002	8.212e-002	1.015e-001	5.910e-002
5	5.049e-002	4.521e-002	5.517e-002	6.731e-002	3.428e-002
7.5	2.054e-002	2.225e-002	2.116e-002	2.662e-002	1.212e-002
10	1.091e-002	1.346e-002	1.001e-002	1.453e-002	5.647e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.996e-001	2.334e-001	2.079e-001	1.814e-001	1.758e-001
0.02	2.006e-001	2.353e-001	2.067e-001	1.839e-001	1.766e-001
0.03	2.050e-001	2.355e-001	2.140e-001	1.883e-001	1.824e-001
0.05	2.323e-001	2.558e-001	2.477e-001	2.172e-001	2.085e-001
0.075	2.860e-001	3.045e-001	3.047e-001	2.713e-001	2.637e-001
0.1	3.442e-001	3.710e-001	3.501e-001	3.396e-001	3.160e-001
0.15	4.390e-001	5.274e-001	4.371e-001	4.074e-001	3.842e-001
0.2	5.028e-001	6.093e-001	5.035e-001	4.620e-001	4.365e-001
0.25	5.242e-001	6.259e-001	5.148e-001	4.879e-001	4.681e-001
0.3	5.274e-001	6.187e-001	5.105e-001	5.055e-001	4.747e-001
0.4	4.941e-001	5.692e-001	4.573e-001	4.939e-001	4.558e-001
0.5	4.522e-001	4.983e-001	4.210e-001	4.626e-001	4.270e-001
0.75	3.434e-001	3.423e-001	3.166e-001	3.831e-001	3.316e-001
1	2.632e-001	2.560e-001	2.485e-001	2.910e-001	2.574e-001
1.5	1.708e-001	1.696e-001	1.544e-001	1.976e-001	1.615e-001
2	1.288e-001	1.201e-001	1.180e-001	1.593e-001	1.179e-001
3	7.912e-002	6.776e-002	7.940e-002	1.020e-001	6.726e-002
4	4.898e-002	4.058e-002	5.259e-002	6.496e-002	3.779e-002
5	3.228e-002	2.890e-002	3.532e-002	4.296e-002	2.194e-002
7.5	1.314e-002	1.420e-002	1.363e-002	1.695e-002	7.775e-003

10	6.995e-003	8.570e-003	6.520e-003	9.264e-003	3.626e-003

Source: W65G35 West Valley (Wasatch 65) fault (dip 35)
Region: USGS 2014 Utah
Closest Distance: 19.23 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.631e-001	2.952e-001	2.817e-001	2.396e-001	2.359e-001
0.02	2.648e-001	2.979e-001	2.808e-001	2.432e-001	2.372e-001
0.03	2.719e-001	2.992e-001	2.930e-001	2.496e-001	2.459e-001
0.05	3.117e-001	3.273e-001	3.473e-001	2.905e-001	2.817e-001
0.075	3.879e-001	3.917e-001	4.345e-001	3.697e-001	3.560e-001
0.1	4.675e-001	4.787e-001	5.000e-001	4.634e-001	4.279e-001
0.15	5.929e-001	6.801e-001	6.131e-001	5.545e-001	5.241e-001
0.2	6.741e-001	7.838e-001	6.910e-001	6.224e-001	5.995e-001
0.25	7.017e-001	8.026e-001	7.008e-001	6.568e-001	6.467e-001
0.3	7.059e-001	7.915e-001	6.914e-001	6.814e-001	6.594e-001
0.4	6.645e-001	7.282e-001	6.196e-001	6.715e-001	6.387e-001
0.5	6.137e-001	6.412e-001	5.751e-001	6.361e-001	6.025e-001
0.75	4.722e-001	4.451e-001	4.380e-001	5.304e-001	4.752e-001
1	3.673e-001	3.366e-001	3.441e-001	4.161e-001	3.724e-001
1.5	2.409e-001	2.286e-001	2.128e-001	2.851e-001	2.370e-001
2	1.722e-001	1.553e-001	1.521e-001	2.175e-001	1.641e-001
3	9.910e-002	8.398e-002	9.430e-002	1.305e-001	8.758e-002
4	6.100e-002	5.222e-002	6.135e-002	8.198e-002	4.846e-002
5	4.014e-002	3.691e-002	4.097e-002	5.477e-002	2.789e-002
7.5	1.626e-002	1.805e-002	1.573e-002	2.148e-002	9.786e-003
10	8.531e-003	1.078e-002	7.326e-003	1.152e-002	4.492e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.782e-001	1.962e-001	1.897e-001	1.644e-001	1.624e-001
0.02	1.791e-001	1.983e-001	1.884e-001	1.667e-001	1.630e-001
0.03	1.835e-001	2.002e-001	1.950e-001	1.705e-001	1.684e-001
0.05	2.091e-001	2.203e-001	2.261e-001	1.970e-001	1.929e-001
0.075	2.589e-001	2.651e-001	2.787e-001	2.473e-001	2.445e-001
0.1	3.122e-001	3.250e-001	3.210e-001	3.089e-001	2.938e-001
0.15	3.989e-001	4.627e-001	4.017e-001	3.730e-001	3.582e-001
0.2	4.555e-001	5.315e-001	4.629e-001	4.202e-001	4.073e-001
0.25	4.737e-001	5.407e-001	4.731e-001	4.442e-001	4.366e-001
0.3	4.739e-001	5.285e-001	4.684e-001	4.559e-001	4.429e-001
0.4	4.419e-001	4.803e-001	4.182e-001	4.440e-001	4.253e-001
0.5	4.046e-001	4.207e-001	3.834e-001	4.159e-001	3.984e-001
0.75	3.065e-001	2.895e-001	2.869e-001	3.393e-001	3.104e-001
1	2.368e-001	2.172e-001	2.238e-001	2.647e-001	2.413e-001
1.5	1.544e-001	1.465e-001	1.382e-001	1.808e-001	1.522e-001
2	1.101e-001	9.894e-002	9.843e-002	1.381e-001	1.050e-001
3	6.325e-002	5.358e-002	6.061e-002	8.284e-002	5.598e-002
4	3.904e-002	3.341e-002	3.929e-002	5.248e-002	3.099e-002
5	2.566e-002	2.360e-002	2.622e-002	3.496e-002	1.785e-002
7.5	1.040e-002	1.152e-002	1.014e-002	1.368e-002	6.275e-003
10	5.467e-003	6.863e-003	4.774e-003	7.346e-003	2.884e-003

Source: W50G35 West Valley (Wasatch 50) fault (dip 35)
Region: USGS 2014 Utah
Closest Distance: 19.64 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.532e-001	2.761e-001	2.742e-001	2.332e-001	2.292e-001
0.02	2.548e-001	2.789e-001	2.732e-001	2.367e-001	2.304e-001
0.03	2.620e-001	2.810e-001	2.851e-001	2.429e-001	2.389e-001

0.05	3.009e-001	3.090e-001	3.381e-001	2.827e-001	2.740e-001
0.075	3.753e-001	3.713e-001	4.231e-001	3.601e-001	3.467e-001
0.1	4.528e-001	4.549e-001	4.873e-001	4.518e-001	4.171e-001
0.15	5.744e-001	6.466e-001	5.979e-001	5.417e-001	5.112e-001
0.2	6.524e-001	7.435e-001	6.740e-001	6.076e-001	5.846e-001
0.25	6.785e-001	7.587e-001	6.835e-001	6.413e-001	6.304e-001
0.3	6.816e-001	7.451e-001	6.740e-001	6.649e-001	6.425e-001
0.4	6.404e-001	6.823e-001	6.034e-001	6.541e-001	6.219e-001
0.5	5.914e-001	6.010e-001	5.595e-001	6.190e-001	5.862e-001
0.75	4.548e-001	4.173e-001	4.256e-001	5.145e-001	4.621e-001
1	3.540e-001	3.158e-001	3.337e-001	4.046e-001	3.620e-001
1.5	2.324e-001	2.156e-001	2.060e-001	2.774e-001	2.305e-001
2	1.664e-001	1.472e-001	1.470e-001	2.115e-001	1.597e-001
3	9.695e-002	8.142e-002	9.182e-002	1.284e-001	8.619e-002
4	6.080e-002	5.234e-002	6.057e-002	8.188e-002	4.839e-002
5	4.045e-002	3.738e-002	4.088e-002	5.538e-002	2.815e-002
7.5	1.652e-002	1.843e-002	1.584e-002	2.187e-002	9.938e-003
10	8.704e-003	1.107e-002	7.401e-003	1.177e-002	4.579e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.714e-001	1.833e-001	1.846e-001	1.599e-001	1.577e-001
0.02	1.723e-001	1.854e-001	1.833e-001	1.620e-001	1.583e-001
0.03	1.767e-001	1.877e-001	1.897e-001	1.657e-001	1.635e-001
0.05	2.016e-001	2.075e-001	2.201e-001	1.914e-001	1.875e-001
0.075	2.502e-001	2.507e-001	2.714e-001	2.407e-001	2.379e-001
0.1	3.019e-001	3.080e-001	3.129e-001	3.008e-001	2.861e-001
0.15	3.859e-001	4.387e-001	3.918e-001	3.639e-001	3.490e-001
0.2	4.402e-001	5.028e-001	4.515e-001	4.098e-001	3.968e-001
0.25	4.575e-001	5.099e-001	4.614e-001	4.333e-001	4.252e-001
0.3	4.572e-001	4.965e-001	4.566e-001	4.444e-001	4.311e-001
0.4	4.257e-001	4.495e-001	4.073e-001	4.322e-001	4.138e-001
0.5	3.897e-001	3.938e-001	3.730e-001	4.045e-001	3.874e-001
0.75	2.952e-001	2.712e-001	2.787e-001	3.290e-001	3.017e-001
1	2.281e-001	2.037e-001	2.171e-001	2.574e-001	2.345e-001
1.5	1.489e-001	1.381e-001	1.338e-001	1.758e-001	1.480e-001
2	1.064e-001	9.382e-002	9.514e-002	1.344e-001	1.022e-001
3	6.188e-002	5.195e-002	5.902e-002	8.146e-002	5.509e-002
4	3.891e-002	3.349e-002	3.878e-002	5.242e-002	3.095e-002
5	2.586e-002	2.390e-002	2.617e-002	3.534e-002	1.802e-002
7.5	1.057e-002	1.176e-002	1.020e-002	1.393e-002	6.373e-003
10	5.577e-003	7.045e-003	4.823e-003	7.501e-003	2.940e-003

Source: W35G35 West Valley (Wasatch 35) fault (dip 35)
Region: USGS 2014 Utah
Closest Distance: 20.22 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.415e-001	2.528e-001	2.658e-001	2.259e-001	2.214e-001
0.02	2.430e-001	2.556e-001	2.648e-001	2.292e-001	2.225e-001
0.03	2.502e-001	2.586e-001	2.763e-001	2.352e-001	2.308e-001
0.05	2.882e-001	2.861e-001	3.278e-001	2.738e-001	2.650e-001
0.075	3.603e-001	3.457e-001	4.105e-001	3.493e-001	3.359e-001
0.1	4.352e-001	4.248e-001	4.731e-001	4.386e-001	4.045e-001
0.15	5.520e-001	6.041e-001	5.810e-001	5.269e-001	4.960e-001
0.2	6.264e-001	6.927e-001	6.550e-001	5.908e-001	5.671e-001
0.25	6.506e-001	7.036e-001	6.642e-001	6.236e-001	6.110e-001
0.3	6.527e-001	6.875e-001	6.547e-001	6.462e-001	6.225e-001
0.4	6.120e-001	6.263e-001	5.856e-001	6.344e-001	6.018e-001
0.5	5.651e-001	5.518e-001	5.423e-001	5.996e-001	5.668e-001
0.75	4.346e-001	3.834e-001	4.118e-001	4.969e-001	4.462e-001
1	3.383e-001	2.904e-001	3.223e-001	3.912e-001	3.493e-001
1.5	2.222e-001	1.997e-001	1.985e-001	2.682e-001	2.225e-001
2	1.594e-001	1.373e-001	1.415e-001	2.045e-001	1.543e-001
3	9.337e-002	7.735e-002	8.831e-002	1.244e-001	8.347e-002
4	5.893e-002	5.101e-002	5.829e-002	7.950e-002	4.692e-002
5	3.924e-002	3.644e-002	3.937e-002	5.384e-002	2.730e-002
7.5	1.606e-002	1.801e-002	1.529e-002	2.128e-002	9.638e-003
10	8.465e-003	1.084e-002	7.144e-003	1.144e-002	4.441e-003

Fractile: Mean
Column 1: Spectral Period

Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.633e-001	1.675e-001	1.789e-001	1.547e-001	1.522e-001
0.02	1.642e-001	1.696e-001	1.777e-001	1.567e-001	1.528e-001
0.03	1.686e-001	1.723e-001	1.839e-001	1.603e-001	1.579e-001
0.05	1.928e-001	1.916e-001	2.134e-001	1.852e-001	1.812e-001
0.075	2.398e-001	2.327e-001	2.633e-001	2.331e-001	2.303e-001
0.1	2.898e-001	2.867e-001	3.038e-001	2.916e-001	2.771e-001
0.15	3.702e-001	4.085e-001	3.807e-001	3.535e-001	3.382e-001
0.2	4.220e-001	4.669e-001	4.388e-001	3.980e-001	3.844e-001
0.25	4.381e-001	4.715e-001	4.485e-001	4.209e-001	4.118e-001
0.3	4.373e-001	4.570e-001	4.435e-001	4.315e-001	4.173e-001
0.4	4.065e-001	4.119e-001	3.952e-001	4.189e-001	4.001e-001
0.5	3.722e-001	3.612e-001	3.615e-001	3.916e-001	3.744e-001
0.75	2.819e-001	2.489e-001	2.697e-001	3.177e-001	2.913e-001
1	2.180e-001	1.872e-001	2.096e-001	2.488e-001	2.262e-001
1.5	1.424e-001	1.279e-001	1.289e-001	1.700e-001	1.428e-001
2	1.019e-001	8.749e-002	9.153e-002	1.299e-001	9.867e-002
3	5.959e-002	4.935e-002	5.676e-002	7.892e-002	5.335e-002
4	3.772e-002	3.264e-002	3.732e-002	5.089e-002	3.001e-002
5	2.508e-002	2.329e-002	2.520e-002	3.436e-002	1.747e-002
7.5	1.027e-002	1.149e-002	9.852e-003	1.355e-002	6.180e-003
10	5.424e-003	6.899e-003	4.655e-003	7.292e-003	2.851e-003

Source: W65G50 West Valley (Wasatch 65) fault (dip 50)
Region: USGS 2014 Utah
Closest Distance: 20.82 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.459e-001	2.599e-001	2.750e-001	2.271e-001	2.217e-001
0.02	2.475e-001	2.628e-001	2.740e-001	2.305e-001	2.229e-001
0.03	2.548e-001	2.654e-001	2.859e-001	2.368e-001	2.313e-001
0.05	2.935e-001	2.930e-001	3.390e-001	2.761e-001	2.657e-001
0.075	3.665e-001	3.533e-001	4.243e-001	3.517e-001	3.368e-001
0.1	4.424e-001	4.336e-001	4.886e-001	4.420e-001	4.055e-001
0.15	5.604e-001	6.166e-001	5.995e-001	5.289e-001	4.967e-001
0.2	6.364e-001	7.079e-001	6.757e-001	5.946e-001	5.674e-001
0.25	6.609e-001	7.206e-001	6.852e-001	6.271e-001	6.106e-001
0.3	6.633e-001	7.056e-001	6.758e-001	6.508e-001	6.212e-001
0.4	6.219e-001	6.440e-001	6.051e-001	6.390e-001	5.994e-001
0.5	5.740e-001	5.672e-001	5.611e-001	6.040e-001	5.636e-001
0.75	4.414e-001	3.935e-001	4.268e-001	5.033e-001	4.421e-001
1	3.423e-001	2.975e-001	3.347e-001	3.914e-001	3.455e-001
1.5	2.242e-001	2.031e-001	2.067e-001	2.675e-001	2.193e-001
2	1.604e-001	1.389e-001	1.477e-001	2.032e-001	1.517e-001
3	9.239e-002	7.634e-002	9.141e-002	1.212e-001	8.064e-002
4	5.695e-002	4.844e-002	5.924e-002	7.575e-002	4.438e-002
5	3.733e-002	3.412e-002	3.944e-002	5.029e-002	2.546e-002
7.5	1.514e-002	1.677e-002	1.514e-002	1.972e-002	8.912e-003
10	7.933e-003	1.006e-002	7.042e-003	1.054e-002	4.086e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.664e-001	1.723e-001	1.851e-001	1.556e-001	1.525e-001
0.02	1.672e-001	1.744e-001	1.838e-001	1.577e-001	1.530e-001
0.03	1.717e-001	1.770e-001	1.903e-001	1.613e-001	1.582e-001
0.05	1.964e-001	1.964e-001	2.207e-001	1.868e-001	1.817e-001
0.075	2.440e-001	2.380e-001	2.721e-001	2.348e-001	2.309e-001
0.1	2.946e-001	2.929e-001	3.137e-001	2.940e-001	2.778e-001
0.15	3.760e-001	4.173e-001	3.928e-001	3.550e-001	3.387e-001
0.2	4.289e-001	4.776e-001	4.527e-001	4.006e-001	3.847e-001
0.25	4.452e-001	4.833e-001	4.626e-001	4.233e-001	4.115e-001
0.3	4.446e-001	4.694e-001	4.578e-001	4.346e-001	4.164e-001
0.4	4.131e-001	4.237e-001	4.084e-001	4.220e-001	3.984e-001
0.5	3.781e-001	3.714e-001	3.741e-001	3.945e-001	3.722e-001
0.75	2.864e-001	2.556e-001	2.796e-001	3.218e-001	2.885e-001
1	2.205e-001	1.917e-001	2.178e-001	2.490e-001	2.237e-001

1.5	1.437e-001	1.301e-001	1.342e-001	1.696e-001	1.408e-001
2	1.025e-001	8.852e-002	9.557e-002	1.291e-001	9.701e-002
3	5.898e-002	4.871e-002	5.875e-002	7.690e-002	5.154e-002
4	3.645e-002	3.099e-002	3.793e-002	4.849e-002	2.838e-002
5	2.386e-002	2.182e-002	2.524e-002	3.209e-002	1.629e-002
7.5	9.683e-003	1.070e-002	9.756e-003	1.256e-002	5.715e-003
10	5.084e-003	6.405e-003	4.589e-003	6.720e-003	2.624e-003

Source: W50G50 West Valley (Wasatch 50) fault (dip 50)
Region: USGS 2014 Utah
Closest Distance: 20.95 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.375e-001	2.456e-001	2.658e-001	2.221e-001	2.166e-001
0.02	2.391e-001	2.484e-001	2.648e-001	2.254e-001	2.177e-001
0.03	2.463e-001	2.516e-001	2.763e-001	2.314e-001	2.259e-001
0.05	2.840e-001	2.788e-001	3.278e-001	2.697e-001	2.596e-001
0.075	3.553e-001	3.374e-001	4.105e-001	3.440e-001	3.294e-001
0.1	4.293e-001	4.149e-001	4.731e-001	4.323e-001	3.969e-001
0.15	5.441e-001	5.901e-001	5.810e-001	5.188e-001	4.865e-001
0.2	6.174e-001	6.762e-001	6.550e-001	5.825e-001	5.560e-001
0.25	6.409e-001	6.862e-001	6.642e-001	6.147e-001	5.982e-001
0.3	6.426e-001	6.698e-001	6.547e-001	6.372e-001	6.086e-001
0.4	6.017e-001	6.093e-001	5.856e-001	6.248e-001	5.872e-001
0.5	5.554e-001	5.368e-001	5.423e-001	5.902e-001	5.522e-001
0.75	4.270e-001	3.728e-001	4.118e-001	4.898e-001	4.336e-001
1	3.316e-001	2.821e-001	3.223e-001	3.831e-001	3.389e-001
1.5	2.175e-001	1.939e-001	1.985e-001	2.622e-001	2.155e-001
2	1.558e-001	1.332e-001	1.415e-001	1.993e-001	1.492e-001
3	9.112e-002	7.499e-002	8.831e-002	1.206e-001	8.054e-002
4	5.749e-002	4.943e-002	5.829e-002	7.699e-002	4.523e-002
5	3.825e-002	3.531e-002	3.937e-002	5.200e-002	2.631e-002
7.5	1.567e-002	1.751e-002	1.529e-002	2.057e-002	9.290e-003
10	8.259e-003	1.056e-002	7.144e-003	1.105e-002	4.280e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.606e-001	1.626e-001	1.789e-001	1.521e-001	1.489e-001
0.02	1.615e-001	1.647e-001	1.777e-001	1.540e-001	1.494e-001
0.03	1.659e-001	1.675e-001	1.839e-001	1.576e-001	1.545e-001
0.05	1.899e-001	1.865e-001	2.134e-001	1.823e-001	1.775e-001
0.075	2.363e-001	2.269e-001	2.633e-001	2.294e-001	2.257e-001
0.1	2.856e-001	2.797e-001	3.038e-001	2.873e-001	2.717e-001
0.15	3.647e-001	3.985e-001	3.807e-001	3.479e-001	3.316e-001
0.2	4.157e-001	4.553e-001	4.388e-001	3.921e-001	3.766e-001
0.25	4.313e-001	4.594e-001	4.485e-001	4.146e-001	4.029e-001
0.3	4.304e-001	4.449e-001	4.435e-001	4.253e-001	4.077e-001
0.4	3.996e-001	4.005e-001	3.952e-001	4.124e-001	3.901e-001
0.5	3.657e-001	3.512e-001	3.615e-001	3.854e-001	3.645e-001
0.75	2.769e-001	2.420e-001	2.697e-001	3.131e-001	2.829e-001
1	2.136e-001	1.818e-001	2.096e-001	2.437e-001	2.194e-001
1.5	1.394e-001	1.241e-001	1.289e-001	1.662e-001	1.383e-001
2	9.961e-002	8.489e-002	9.153e-002	1.266e-001	9.543e-002
3	5.816e-002	4.785e-002	5.676e-002	7.655e-002	5.148e-002
4	3.679e-002	3.163e-002	3.733e-002	4.929e-002	2.892e-002
5	2.445e-002	2.257e-002	2.520e-002	3.319e-002	1.684e-002
7.5	1.002e-002	1.117e-002	9.852e-003	1.310e-002	5.957e-003
10	5.293e-003	6.723e-003	4.655e-003	7.043e-003	2.749e-003

Source: W35G50 West Valley (Wasatch 35) fault (dip 50)
Region: USGS 2014 Utah
Closest Distance: 21.33 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014

Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.315e-001	2.420e-001	2.573e-001	2.164e-001	2.105e-001
0.02	2.330e-001	2.448e-001	2.562e-001	2.195e-001	2.115e-001
0.03	2.401e-001	2.481e-001	2.673e-001	2.253e-001	2.195e-001
0.05	2.769e-001	2.752e-001	3.173e-001	2.626e-001	2.525e-001
0.075	3.467e-001	3.333e-001	3.975e-001	3.352e-001	3.208e-001
0.1	4.192e-001	4.100e-001	4.586e-001	4.216e-001	3.867e-001
0.15	5.321e-001	5.831e-001	5.637e-001	5.071e-001	4.744e-001
0.2	6.037e-001	6.680e-001	6.356e-001	5.688e-001	5.421e-001
0.25	6.264e-001	6.776e-001	6.446e-001	6.005e-001	5.831e-001
0.3	6.278e-001	6.610e-001	6.350e-001	6.221e-001	5.931e-001
0.4	5.873e-001	6.009e-001	5.674e-001	6.091e-001	5.719e-001
0.5	5.417e-001	5.295e-001	5.248e-001	5.748e-001	5.376e-001
0.75	4.158e-001	3.676e-001	3.979e-001	4.755e-001	4.221e-001
1	3.229e-001	2.781e-001	3.107e-001	3.731e-001	3.298e-001
1.5	2.119e-001	1.910e-001	1.910e-001	2.555e-001	2.099e-001
2	1.517e-001	1.312e-001	1.359e-001	1.942e-001	1.455e-001
3	8.887e-002	7.383e-002	8.478e-002	1.180e-001	7.888e-002
4	5.613e-002	4.865e-002	5.600e-002	7.550e-002	4.438e-002
5	3.738e-002	3.476e-002	3.785e-002	5.110e-002	2.582e-002
7.5	1.534e-002	1.726e-002	1.474e-002	2.023e-002	9.116e-003
10	8.092e-003	1.043e-002	6.883e-003	1.086e-002	4.200e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.565e-001	1.602e-001	1.732e-001	1.480e-001	1.446e-001
0.02	1.573e-001	1.623e-001	1.719e-001	1.499e-001	1.451e-001
0.03	1.616e-001	1.652e-001	1.780e-001	1.533e-001	1.500e-001
0.05	1.851e-001	1.841e-001	2.066e-001	1.773e-001	1.725e-001
0.075	2.305e-001	2.240e-001	2.550e-001	2.234e-001	2.196e-001
0.1	2.788e-001	2.763e-001	2.945e-001	2.799e-001	2.645e-001
0.15	3.564e-001	3.936e-001	3.694e-001	3.396e-001	3.230e-001
0.2	4.062e-001	4.495e-001	4.258e-001	3.825e-001	3.669e-001
0.25	4.214e-001	4.534e-001	4.352e-001	4.046e-001	3.923e-001
0.3	4.202e-001	4.389e-001	4.302e-001	4.149e-001	3.970e-001
0.4	3.899e-001	3.949e-001	3.829e-001	4.018e-001	3.797e-001
0.5	3.565e-001	3.463e-001	3.499e-001	3.752e-001	3.547e-001
0.75	2.696e-001	2.386e-001	2.606e-001	3.039e-001	2.753e-001
1	2.080e-001	1.792e-001	2.022e-001	2.373e-001	2.135e-001
1.5	1.358e-001	1.223e-001	1.241e-001	1.620e-001	1.347e-001
2	9.699e-002	8.361e-002	8.791e-002	1.234e-001	9.308e-002
3	5.672e-002	4.711e-002	5.449e-002	7.488e-002	5.041e-002
4	3.592e-002	3.113e-002	3.586e-002	4.833e-002	2.838e-002
5	2.390e-002	2.222e-002	2.423e-002	3.261e-002	1.652e-002
7.5	9.810e-003	1.102e-002	9.495e-003	1.288e-002	5.846e-003
10	5.185e-003	6.637e-003	4.485e-003	6.921e-003	2.697e-003

Source: W50G65 West Valley (Wasatch 50) fault (dip 65)
Region: USGS 2014 Utah
Closest Distance: 22.46 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.247e-001	2.318e-001	2.565e-001	2.089e-001	2.016e-001
0.02	2.261e-001	2.346e-001	2.554e-001	2.119e-001	2.026e-001
0.03	2.331e-001	2.381e-001	2.665e-001	2.176e-001	2.103e-001
0.05	2.693e-001	2.648e-001	3.163e-001	2.539e-001	2.424e-001
0.075	3.376e-001	3.214e-001	3.963e-001	3.243e-001	3.084e-001
0.1	4.084e-001	3.957e-001	4.572e-001	4.084e-001	3.722e-001
0.15	5.182e-001	5.629e-001	5.620e-001	4.911e-001	4.566e-001
0.2	5.877e-001	6.443e-001	6.337e-001	5.515e-001	5.214e-001
0.25	6.093e-001	6.527e-001	6.426e-001	5.821e-001	5.599e-001
0.3	6.102e-001	6.357e-001	6.331e-001	6.033e-001	5.686e-001
0.4	5.697e-001	5.770e-001	5.656e-001	5.894e-001	5.470e-001
0.5	5.251e-001	5.084e-001	5.231e-001	5.555e-001	5.132e-001
0.75	4.027e-001	3.527e-001	3.965e-001	4.597e-001	4.017e-001
1	3.120e-001	2.665e-001	3.096e-001	3.586e-001	3.134e-001
1.5	2.044e-001	1.829e-001	1.903e-001	2.452e-001	1.992e-001
2	1.461e-001	1.256e-001	1.353e-001	1.857e-001	1.379e-001
3	8.553e-002	7.056e-002	8.443e-002	1.124e-001	7.472e-002
4	5.404e-002	4.646e-002	5.578e-002	7.188e-002	4.203e-002

5	3.597e-002	3.320e-002	3.770e-002	4.854e-002	2.445e-002
7.5	1.478e-002	1.656e-002	1.468e-002	1.924e-002	8.634e-003
10	7.799e-003	1.004e-002	6.857e-003	1.032e-002	3.979e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.518e-001	1.534e-001	1.726e-001	1.427e-001	1.384e-001
0.02	1.525e-001	1.554e-001	1.714e-001	1.445e-001	1.389e-001
0.03	1.568e-001	1.584e-001	1.774e-001	1.478e-001	1.436e-001
0.05	1.798e-001	1.769e-001	2.059e-001	1.712e-001	1.654e-001
0.075	2.241e-001	2.157e-001	2.542e-001	2.158e-001	2.109e-001
0.1	2.712e-001	2.662e-001	2.935e-001	2.708e-001	2.542e-001
0.15	3.466e-001	3.793e-001	3.683e-001	3.284e-001	3.104e-001
0.2	3.950e-001	4.329e-001	4.245e-001	3.703e-001	3.524e-001
0.25	4.095e-001	4.362e-001	4.339e-001	3.918e-001	3.763e-001
0.3	4.081e-001	4.216e-001	4.289e-001	4.020e-001	3.802e-001
0.4	3.780e-001	3.789e-001	3.817e-001	3.886e-001	3.628e-001
0.5	3.455e-001	3.324e-001	3.487e-001	3.624e-001	3.383e-001
0.75	2.610e-001	2.288e-001	2.597e-001	2.938e-001	2.618e-001
1	2.010e-001	1.717e-001	2.014e-001	2.280e-001	2.028e-001
1.5	1.310e-001	1.171e-001	1.236e-001	1.554e-001	1.278e-001
2	9.343e-002	7.998e-002	8.756e-002	1.180e-001	8.822e-002
3	5.459e-002	4.502e-002	5.427e-002	7.133e-002	4.776e-002
4	3.458e-002	2.973e-002	3.571e-002	4.601e-002	2.688e-002
5	2.300e-002	2.122e-002	2.413e-002	3.098e-002	1.565e-002
7.5	9.456e-003	1.057e-002	9.460e-003	1.226e-002	5.537e-003
10	4.998e-003	6.392e-003	4.468e-003	6.577e-003	2.555e-003

Source: W65G65 West Valley (Wasatch 65) fault (dip 65)
Region: USGS 2014 Utah
Closest Distance: 22.46 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.284e-001	2.318e-001	2.658e-001	2.116e-001	2.044e-001
0.02	2.299e-001	2.346e-001	2.648e-001	2.146e-001	2.054e-001
0.03	2.371e-001	2.381e-001	2.763e-001	2.205e-001	2.133e-001
0.05	2.740e-001	2.648e-001	3.278e-001	2.574e-001	2.457e-001
0.075	3.433e-001	3.214e-001	4.105e-001	3.285e-001	3.126e-001
0.1	4.149e-001	3.957e-001	4.731e-001	4.138e-001	3.770e-001
0.15	5.257e-001	5.629e-001	5.810e-001	4.965e-001	4.623e-001
0.2	5.963e-001	6.443e-001	6.550e-001	5.581e-001	5.278e-001
0.25	6.182e-001	6.527e-001	6.642e-001	5.890e-001	5.668e-001
0.3	6.192e-001	6.357e-001	6.547e-001	6.108e-001	5.755e-001
0.4	5.783e-001	5.770e-001	5.856e-001	5.971e-001	5.534e-001
0.5	5.332e-001	5.084e-001	5.423e-001	5.630e-001	5.192e-001
0.75	4.094e-001	3.527e-001	4.118e-001	4.672e-001	4.059e-001
1	3.170e-001	2.665e-001	3.223e-001	3.627e-001	3.165e-001
1.5	2.075e-001	1.829e-001	1.985e-001	2.477e-001	2.009e-001
2	1.498e-001	1.268e-001	1.429e-001	1.893e-001	1.402e-001
3	8.706e-002	7.088e-002	8.870e-002	1.135e-001	7.522e-002
4	5.347e-002	4.540e-002	5.696e-002	7.042e-002	4.108e-002
5	3.475e-002	3.170e-002	3.760e-002	4.635e-002	2.335e-002
7.5	1.406e-002	1.560e-002	1.440e-002	1.812e-002	8.132e-003
10	7.363e-003	9.392e-003	6.683e-003	9.653e-003	3.722e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.543e-001	1.534e-001	1.789e-001	1.446e-001	1.404e-001
0.02	1.551e-001	1.554e-001	1.777e-001	1.465e-001	1.409e-001
0.03	1.595e-001	1.584e-001	1.839e-001	1.499e-001	1.457e-001
0.05	1.829e-001	1.769e-001	2.134e-001	1.737e-001	1.678e-001
0.075	2.279e-001	2.157e-001	2.633e-001	2.188e-001	2.139e-001
0.1	2.755e-001	2.662e-001	3.038e-001	2.745e-001	2.576e-001
0.15	3.517e-001	3.793e-001	3.807e-001	3.323e-001	3.144e-001
0.2	4.009e-001	4.329e-001	4.388e-001	3.750e-001	3.569e-001

0.25	4.155e-001	4.362e-001	4.485e-001	3.965e-001	3.810e-001
0.3	4.143e-001	4.216e-001	4.435e-001	4.071e-001	3.849e-001
0.4	3.838e-001	3.789e-001	3.952e-001	3.938e-001	3.672e-001
0.5	3.509e-001	3.324e-001	3.615e-001	3.674e-001	3.423e-001
0.75	2.654e-001	2.288e-001	2.697e-001	2.986e-001	2.646e-001
1	2.042e-001	1.717e-001	2.097e-001	2.307e-001	2.048e-001
1.5	1.330e-001	1.171e-001	1.289e-001	1.570e-001	1.289e-001
2	9.577e-002	8.076e-002	9.243e-002	1.202e-001	8.969e-002
3	5.558e-002	4.522e-002	5.702e-002	7.200e-002	4.808e-002
4	3.422e-002	2.905e-002	3.648e-002	4.508e-002	2.627e-002
5	2.221e-002	2.026e-002	2.407e-002	2.958e-002	1.494e-002
7.5	8.997e-003	9.953e-003	9.279e-003	1.154e-002	5.215e-003
10	4.719e-003	5.979e-003	4.355e-003	6.153e-003	2.390e-003

Source: W35G65 West Valley (Wasatch 35) fault (dip 65)
Region: USGS 2014 Utah
Closest Distance: 22.47 km
Amplitude Units: Acceleration (g)
Magnitude: 6.50 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.217e-001	2.317e-001	2.491e-001	2.067e-001	1.993e-001
0.02	2.231e-001	2.345e-001	2.480e-001	2.096e-001	2.001e-001
0.03	2.300e-001	2.380e-001	2.588e-001	2.152e-001	2.078e-001
0.05	2.656e-001	2.647e-001	3.072e-001	2.510e-001	2.395e-001
0.075	3.330e-001	3.213e-001	3.851e-001	3.208e-001	3.049e-001
0.1	4.031e-001	3.956e-001	4.447e-001	4.041e-001	3.681e-001
0.15	5.120e-001	5.627e-001	5.470e-001	4.866e-001	4.518e-001
0.2	5.808e-001	6.440e-001	6.170e-001	5.460e-001	5.160e-001
0.25	6.022e-001	6.524e-001	6.257e-001	5.765e-001	5.542e-001
0.3	6.029e-001	6.354e-001	6.161e-001	5.972e-001	5.628e-001
0.4	5.628e-001	5.767e-001	5.500e-001	5.832e-001	5.415e-001
0.5	5.185e-001	5.082e-001	5.081e-001	5.494e-001	5.082e-001
0.75	3.972e-001	3.526e-001	3.846e-001	4.537e-001	3.980e-001
1	3.080e-001	2.664e-001	2.998e-001	3.551e-001	3.106e-001
1.5	2.018e-001	1.828e-001	1.839e-001	2.430e-001	1.977e-001
2	1.444e-001	1.255e-001	1.306e-001	1.843e-001	1.371e-001
3	8.461e-002	7.053e-002	8.144e-002	1.119e-001	7.455e-002
4	5.350e-002	4.644e-002	5.383e-002	7.171e-002	4.200e-002
5	3.564e-002	3.318e-002	3.640e-002	4.852e-002	2.444e-002
7.5	1.466e-002	1.655e-002	1.421e-002	1.924e-002	8.630e-003
10	7.740e-003	1.004e-002	6.633e-003	1.031e-002	3.976e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.497e-001	1.533e-001	1.677e-001	1.412e-001	1.368e-001
0.02	1.505e-001	1.553e-001	1.664e-001	1.429e-001	1.372e-001
0.03	1.547e-001	1.583e-001	1.722e-001	1.462e-001	1.419e-001
0.05	1.774e-001	1.768e-001	2.000e-001	1.692e-001	1.634e-001
0.075	2.211e-001	2.156e-001	2.470e-001	2.134e-001	2.084e-001
0.1	2.677e-001	2.661e-001	2.855e-001	2.678e-001	2.513e-001
0.15	3.425e-001	3.792e-001	3.585e-001	3.253e-001	3.070e-001
0.2	3.903e-001	4.327e-001	4.133e-001	3.665e-001	3.486e-001
0.25	4.046e-001	4.360e-001	4.224e-001	3.878e-001	3.723e-001
0.3	4.032e-001	4.215e-001	4.174e-001	3.977e-001	3.762e-001
0.4	3.733e-001	3.788e-001	3.712e-001	3.844e-001	3.591e-001
0.5	3.411e-001	3.322e-001	3.387e-001	3.584e-001	3.349e-001
0.75	2.575e-001	2.288e-001	2.519e-001	2.899e-001	2.594e-001
1	1.984e-001	1.716e-001	1.950e-001	2.258e-001	2.010e-001
1.5	1.293e-001	1.170e-001	1.195e-001	1.540e-001	1.268e-001
2	9.229e-002	7.995e-002	8.449e-002	1.170e-001	8.768e-002
3	5.400e-002	4.500e-002	5.235e-002	7.102e-002	4.764e-002
4	3.424e-002	2.971e-002	3.447e-002	4.590e-002	2.686e-002
5	2.278e-002	2.121e-002	2.330e-002	3.096e-002	1.564e-002
7.5	9.376e-003	1.056e-002	9.155e-003	1.225e-002	5.534e-003
10	4.960e-003	6.389e-003	4.322e-003	6.574e-003	2.553e-003

Source: Great Salt Lake fault zone, Antelope Island [2369c]
Region: USGS 2014 Utah
Closest Distance: 30.46 km
Amplitude Units: Acceleration (g)
Magnitude: 6.93 Mw

Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.083e-001	2.326e-001	2.275e-001	1.814e-001	1.918e-001
0.02	2.092e-001	2.352e-001	2.253e-001	1.839e-001	1.923e-001
0.03	2.150e-001	2.384e-001	2.338e-001	1.890e-001	1.987e-001
0.05	2.460e-001	2.644e-001	2.743e-001	2.175e-001	2.278e-001
0.075	3.053e-001	3.194e-001	3.396e-001	2.731e-001	2.893e-001
0.1	3.675e-001	3.921e-001	3.876e-001	3.408e-001	3.494e-001
0.15	4.663e-001	5.618e-001	4.700e-001	4.040e-001	4.295e-001
0.2	5.322e-001	6.516e-001	5.302e-001	4.556e-001	4.915e-001
0.25	5.585e-001	6.712e-001	5.413e-001	4.924e-001	5.293e-001
0.3	5.658e-001	6.644e-001	5.366e-001	5.222e-001	5.398e-001
0.4	5.360e-001	6.224e-001	4.856e-001	5.129e-001	5.230e-001
0.5	4.996e-001	5.611e-001	4.535e-001	4.895e-001	4.942e-001
0.75	3.910e-001	4.093e-001	3.480e-001	4.129e-001	3.940e-001
1	3.074e-001	3.174e-001	2.743e-001	3.254e-001	3.127e-001
1.5	2.116e-001	2.242e-001	1.779e-001	2.377e-001	2.065e-001
2	1.603e-001	1.633e-001	1.359e-001	1.885e-001	1.536e-001
3	1.034e-001	1.017e-001	9.441e-002	1.249e-001	9.277e-002
4	6.897e-002	7.097e-002	6.647e-002	8.305e-002	5.539e-002
5	4.740e-002	5.203e-002	4.690e-002	5.708e-002	3.360e-002
7.5	2.130e-002	2.808e-002	2.028e-002	2.394e-002	1.290e-002
10	1.175e-002	1.826e-002	1.005e-002	1.235e-002	6.341e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.407e-001	1.547e-001	1.532e-001	1.234e-001	1.315e-001
0.02	1.411e-001	1.566e-001	1.512e-001	1.249e-001	1.318e-001
0.03	1.446e-001	1.594e-001	1.556e-001	1.278e-001	1.355e-001
0.05	1.643e-001	1.774e-001	1.786e-001	1.459e-001	1.553e-001
0.075	2.028e-001	2.152e-001	2.178e-001	1.808e-001	1.974e-001
0.1	2.442e-001	2.648e-001	2.488e-001	2.248e-001	2.381e-001
0.15	3.121e-001	3.802e-001	3.080e-001	2.688e-001	2.913e-001
0.2	3.578e-001	4.400e-001	3.552e-001	3.045e-001	3.315e-001
0.25	3.754e-001	4.511e-001	3.655e-001	3.299e-001	3.551e-001
0.3	3.785e-001	4.433e-001	3.635e-001	3.466e-001	3.604e-001
0.4	3.557e-001	4.112e-001	3.277e-001	3.373e-001	3.466e-001
0.5	3.289e-001	3.691e-001	3.023e-001	3.188e-001	3.256e-001
0.75	2.538e-001	2.671e-001	2.279e-001	2.636e-001	2.568e-001
1	1.983e-001	2.056e-001	1.785e-001	2.068e-001	2.023e-001
1.5	1.357e-001	1.442e-001	1.156e-001	1.507e-001	1.325e-001
2	1.026e-001	1.044e-001	8.791e-002	1.197e-001	9.828e-002
3	6.610e-002	6.517e-002	6.068e-002	7.924e-002	5.930e-002
4	4.419e-002	4.559e-002	4.256e-002	5.317e-002	3.542e-002
5	3.034e-002	3.340e-002	3.002e-002	3.643e-002	2.151e-002
7.5	1.364e-002	1.799e-002	1.306e-002	1.525e-002	8.270e-003
10	7.541e-003	1.167e-002	6.551e-003	7.870e-003	4.072e-003

Source: Great Salt Lake fault zone, Fremont Island s [2369b]
Region: USGS 2014 Utah
Closest Distance: 34.04 km
Amplitude Units: Acceleration (g)
Magnitude: 6.83 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.811e-001	2.019e-001	1.998e-001	1.600e-001	1.628e-001
0.02	1.819e-001	2.045e-001	1.978e-001	1.621e-001	1.632e-001
0.03	1.873e-001	2.082e-001	2.054e-001	1.666e-001	1.689e-001
0.05	2.153e-001	2.327e-001	2.414e-001	1.924e-001	1.949e-001
0.075	2.686e-001	2.827e-001	3.001e-001	2.427e-001	2.489e-001
0.1	3.247e-001	3.481e-001	3.447e-001	3.046e-001	3.012e-001
0.15	4.132e-001	4.981e-001	4.214e-001	3.630e-001	3.703e-001
0.2	4.711e-001	5.756e-001	4.764e-001	4.097e-001	4.228e-001
0.25	4.931e-001	5.898e-001	4.863e-001	4.424e-001	4.539e-001
0.3	4.977e-001	5.802e-001	4.810e-001	4.682e-001	4.613e-001
0.4	4.679e-001	5.393e-001	4.328e-001	4.553e-001	4.442e-001
0.5	4.339e-001	4.851e-001	4.014e-001	4.315e-001	4.175e-001

0.75	3.367e-001	3.500e-001	3.054e-001	3.620e-001	3.295e-001
1	2.622e-001	2.690e-001	2.383e-001	2.819e-001	2.598e-001
1.5	1.780e-001	1.883e-001	1.513e-001	2.023e-001	1.703e-001
2	1.351e-001	1.378e-001	1.150e-001	1.602e-001	1.273e-001
3	8.779e-002	8.660e-002	8.008e-002	1.068e-001	7.771e-002
4	5.823e-002	5.901e-002	5.636e-002	7.114e-002	4.643e-002
5	3.994e-002	4.322e-002	3.968e-002	4.880e-002	2.809e-002
7.5	1.786e-002	2.341e-002	1.696e-002	2.044e-002	1.063e-002
10	9.875e-003	1.529e-002	8.326e-003	1.071e-002	5.179e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.221e-001	1.338e-001	1.345e-001	1.085e-001	1.114e-001
0.02	1.224e-001	1.356e-001	1.327e-001	1.098e-001	1.115e-001
0.03	1.256e-001	1.386e-001	1.367e-001	1.123e-001	1.149e-001
0.05	1.434e-001	1.554e-001	1.571e-001	1.286e-001	1.324e-001
0.075	1.778e-001	1.895e-001	1.925e-001	1.601e-001	1.691e-001
0.1	2.149e-001	2.338e-001	2.213e-001	2.002e-001	2.043e-001
0.15	2.754e-001	3.351e-001	2.761e-001	2.405e-001	2.499e-001
0.2	3.155e-001	3.864e-001	3.191e-001	2.727e-001	2.839e-001
0.25	3.303e-001	3.943e-001	3.283e-001	2.954e-001	3.031e-001
0.3	3.320e-001	3.854e-001	3.258e-001	3.099e-001	3.067e-001
0.4	3.098e-001	3.551e-001	2.921e-001	2.988e-001	2.933e-001
0.5	2.851e-001	3.181e-001	2.676e-001	2.806e-001	2.742e-001
0.75	2.183e-001	2.278e-001	2.000e-001	2.309e-001	2.143e-001
1	1.689e-001	1.738e-001	1.550e-001	1.791e-001	1.679e-001
1.5	1.141e-001	1.209e-001	9.825e-002	1.282e-001	1.092e-001
2	8.640e-002	8.803e-002	7.443e-002	1.017e-001	8.141e-002
3	5.608e-002	5.542e-002	5.147e-002	6.775e-002	4.966e-002
4	3.730e-002	3.787e-002	3.609e-002	4.554e-002	2.969e-002
5	2.556e-002	2.772e-002	2.540e-002	3.114e-002	1.798e-002
7.5	1.144e-002	1.499e-002	1.092e-002	1.302e-002	6.817e-003
10	6.334e-003	9.760e-003	5.425e-003	6.827e-003	3.326e-003

Source: Wasatch fault, Brigham City section [2351d]
Region: USGS 2014 Utah
Closest Distance: 34.91 km
Amplitude Units: Acceleration (g)
Magnitude: 6.95 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.941e-001	2.099e-001	2.156e-001	1.701e-001	1.805e-001
0.02	1.948e-001	2.125e-001	2.133e-001	1.725e-001	1.811e-001
0.03	2.005e-001	2.161e-001	2.213e-001	1.775e-001	1.871e-001
0.05	2.299e-001	2.408e-001	2.593e-001	2.046e-001	2.150e-001
0.075	2.856e-001	2.918e-001	3.208e-001	2.561e-001	2.737e-001
0.1	3.439e-001	3.588e-001	3.664e-001	3.198e-001	3.305e-001
0.15	4.352e-001	5.144e-001	4.446e-001	3.765e-001	4.054e-001
0.2	4.969e-001	5.966e-001	5.020e-001	4.261e-001	4.630e-001
0.25	5.217e-001	6.144e-001	5.130e-001	4.617e-001	4.979e-001
0.3	5.289e-001	6.075e-001	5.086e-001	4.927e-001	5.069e-001
0.4	5.005e-001	5.695e-001	4.602e-001	4.827e-001	4.896e-001
0.5	4.665e-001	5.149e-001	4.294e-001	4.603e-001	4.612e-001
0.75	3.656e-001	3.763e-001	3.290e-001	3.921e-001	3.649e-001
1	2.856e-001	2.913e-001	2.589e-001	3.035e-001	2.885e-001
1.5	1.960e-001	2.056e-001	1.678e-001	2.210e-001	1.897e-001
2	1.543e-001	1.562e-001	1.337e-001	1.809e-001	1.465e-001
3	1.056e-001	1.039e-001	9.943e-002	1.258e-001	9.314e-002
4	7.234e-002	7.459e-002	7.234e-002	8.549e-002	5.695e-002
5	5.055e-002	5.598e-002	5.199e-002	5.906e-002	3.516e-002
7.5	2.322e-002	3.101e-002	2.291e-002	2.527e-002	1.371e-002
10	1.307e-002	2.068e-002	1.154e-002	1.321e-002	6.849e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.310e-001	1.394e-001	1.452e-001	1.155e-001	1.237e-001
0.02	1.313e-001	1.412e-001	1.431e-001	1.169e-001	1.239e-001

0.03	1.347e-001	1.442e-001	1.473e-001	1.198e-001	1.275e-001
0.05	1.533e-001	1.612e-001	1.688e-001	1.370e-001	1.464e-001
0.075	1.894e-001	1.961e-001	2.058e-001	1.692e-001	1.865e-001
0.1	2.280e-001	2.415e-001	2.352e-001	2.106e-001	2.248e-001
0.15	2.907e-001	3.469e-001	2.914e-001	2.500e-001	2.744e-001
0.2	3.334e-001	4.016e-001	3.363e-001	2.842e-001	3.117e-001
0.25	3.501e-001	4.118e-001	3.463e-001	3.088e-001	3.334e-001
0.3	3.534e-001	4.045e-001	3.445e-001	3.266e-001	3.379e-001
0.4	3.318e-001	3.758e-001	3.106e-001	3.171e-001	3.239e-001
0.5	3.069e-001	3.384e-001	2.863e-001	2.995e-001	3.034e-001
0.75	2.372e-001	2.454e-001	2.155e-001	2.502e-001	2.376e-001
1	1.841e-001	1.886e-001	1.684e-001	1.928e-001	1.866e-001
1.5	1.258e-001	1.323e-001	1.090e-001	1.400e-001	1.217e-001
2	9.875e-002	9.992e-002	8.651e-002	1.149e-001	9.368e-002
3	6.746e-002	6.656e-002	6.391e-002	7.984e-002	5.953e-002
4	4.635e-002	4.793e-002	4.632e-002	5.473e-002	3.642e-002
5	3.235e-002	3.594e-002	3.328e-002	3.769e-002	2.250e-002
7.5	1.488e-002	1.987e-002	1.476e-002	1.610e-002	8.789e-003
10	8.389e-003	1.322e-002	7.520e-003	8.418e-003	4.398e-003

Source: Oquirrh-Southern Oquirrh Mountains fault [2398_2399]
Region: USGS 2014 Utah
Closest Distance: 44.03 km
Amplitude Units: Acceleration (g)
Magnitude: 7.17 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.778e-001	1.947e-001	1.967e-001	1.516e-001	1.683e-001
0.02	1.783e-001	1.970e-001	1.938e-001	1.537e-001	1.686e-001
0.03	1.831e-001	2.006e-001	2.003e-001	1.581e-001	1.735e-001
0.05	2.089e-001	2.238e-001	2.323e-001	1.809e-001	1.988e-001
0.075	2.578e-001	2.708e-001	2.849e-001	2.231e-001	2.526e-001
0.1	3.093e-001	3.325e-001	3.236e-001	2.761e-001	3.049e-001
0.15	3.906e-001	4.781e-001	3.903e-001	3.199e-001	3.740e-001
0.2	4.477e-001	5.587e-001	4.415e-001	3.628e-001	4.276e-001
0.25	4.739e-001	5.806e-001	4.538e-001	4.004e-001	4.606e-001
0.3	4.837e-001	5.787e-001	4.521e-001	4.340e-001	4.701e-001
0.4	4.616e-001	5.525e-001	4.123e-001	4.259e-001	4.557e-001
0.5	4.334e-001	5.065e-001	3.868e-001	4.094e-001	4.308e-001
0.75	3.437e-001	3.786e-001	2.983e-001	3.545e-001	3.434e-001
1	2.697e-001	2.958e-001	2.356e-001	2.740e-001	2.734e-001
1.5	1.891e-001	2.112e-001	1.568e-001	2.061e-001	1.824e-001
2	1.443e-001	1.556e-001	1.222e-001	1.626e-001	1.369e-001
3	9.587e-002	9.988e-002	8.931e-002	1.096e-001	8.472e-002
4	6.635e-002	7.166e-002	6.641e-002	7.489e-002	5.242e-002
5	4.724e-002	5.513e-002	4.881e-002	5.205e-002	3.297e-002
7.5	2.307e-002	3.323e-002	2.266e-002	2.306e-002	1.333e-002
10	1.331e-002	2.295e-002	1.169e-002	1.177e-002	6.810e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.199e-001	1.292e-001	1.324e-001	1.027e-001	1.152e-001
0.02	1.200e-001	1.309e-001	1.301e-001	1.039e-001	1.153e-001
0.03	1.229e-001	1.337e-001	1.333e-001	1.064e-001	1.181e-001
0.05	1.391e-001	1.496e-001	1.512e-001	1.207e-001	1.351e-001
0.075	1.708e-001	1.816e-001	1.828e-001	1.470e-001	1.717e-001
0.1	2.048e-001	2.233e-001	2.078e-001	1.812e-001	2.069e-001
0.15	2.604e-001	3.217e-001	2.557e-001	2.117e-001	2.525e-001
0.2	2.999e-001	3.754e-001	2.958e-001	2.412e-001	2.872e-001
0.25	3.175e-001	3.887e-001	3.064e-001	2.670e-001	3.078e-001
0.3	3.227e-001	3.850e-001	3.062e-001	2.869e-001	3.127e-001
0.4	3.058e-001	3.646e-001	2.783e-001	2.793e-001	3.011e-001
0.5	2.850e-001	3.329e-001	2.578e-001	2.661e-001	2.831e-001
0.75	2.230e-001	2.471e-001	1.954e-001	2.261e-001	2.234e-001
1	1.739e-001	1.916e-001	1.532e-001	1.740e-001	1.767e-001
1.5	1.213e-001	1.359e-001	1.019e-001	1.306e-001	1.170e-001
2	9.236e-002	9.960e-002	7.908e-002	1.032e-001	8.754e-002
3	6.128e-002	6.402e-002	5.740e-002	6.955e-002	5.414e-002
4	4.251e-002	4.607e-002	4.252e-002	4.794e-002	3.352e-002
5	3.025e-002	3.542e-002	3.124e-002	3.322e-002	2.111e-002
7.5	1.479e-002	2.131e-002	1.460e-002	1.469e-002	8.550e-003
10	8.542e-003	1.468e-002	7.617e-003	7.502e-003	4.373e-003

Source: East Cache fault zone [2352abc]
Region: USGS 2014 Utah
Closest Distance: 48.97 km
Amplitude Units: Acceleration (g)
Magnitude: 7.31 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.723e-001	1.932e-001	1.887e-001	1.444e-001	1.650e-001
0.02	1.726e-001	1.954e-001	1.856e-001	1.464e-001	1.652e-001
0.03	1.770e-001	1.988e-001	1.912e-001	1.506e-001	1.695e-001
0.05	2.010e-001	2.215e-001	2.200e-001	1.712e-001	1.935e-001
0.075	2.468e-001	2.674e-001	2.682e-001	2.091e-001	2.453e-001
0.1	2.951e-001	3.277e-001	3.033e-001	2.570e-001	2.959e-001
0.15	3.723e-001	4.721e-001	3.642e-001	2.946e-001	3.631e-001
0.2	4.279e-001	5.544e-001	4.129e-001	3.344e-001	4.156e-001
0.25	4.556e-001	5.799e-001	4.261e-001	3.735e-001	4.485e-001
0.3	4.674e-001	5.814e-001	4.261e-001	4.089e-001	4.589e-001
0.4	4.491e-001	5.619e-001	3.910e-001	4.021e-001	4.465e-001
0.5	4.238e-001	5.194e-001	3.683e-001	3.887e-001	4.235e-001
0.75	3.388e-001	3.934e-001	2.856e-001	3.398e-001	3.399e-001
1	2.669e-001	3.092e-001	2.263e-001	2.628e-001	2.720e-001
1.5	1.898e-001	2.225e-001	1.535e-001	2.021e-001	1.833e-001
2	1.441e-001	1.638e-001	1.190e-001	1.574e-001	1.374e-001
3	9.711e-002	1.057e-001	8.779e-002	1.084e-001	8.658e-002
4	6.861e-002	7.672e-002	6.706e-002	7.587e-002	5.478e-002
5	4.973e-002	5.973e-002	5.034e-002	5.379e-002	3.507e-002
7.5	2.505e-002	3.690e-002	2.429e-002	2.447e-002	1.455e-002
10	1.485e-002	2.662e-002	1.281e-002	1.238e-002	7.569e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.161e-001	1.282e-001	1.270e-001	9.771e-002	1.129e-001
0.02	1.162e-001	1.298e-001	1.245e-001	9.889e-002	1.129e-001
0.03	1.187e-001	1.325e-001	1.273e-001	1.012e-001	1.153e-001
0.05	1.338e-001	1.480e-001	1.432e-001	1.141e-001	1.314e-001
0.075	1.634e-001	1.792e-001	1.720e-001	1.376e-001	1.666e-001
0.1	1.954e-001	2.200e-001	1.947e-001	1.684e-001	2.007e-001
0.15	2.481e-001	3.175e-001	2.387e-001	1.946e-001	2.449e-001
0.2	2.865e-001	3.724e-001	2.766e-001	2.220e-001	2.789e-001
0.25	3.051e-001	3.882e-001	2.877e-001	2.488e-001	2.995e-001
0.3	3.117e-001	3.869e-001	2.886e-001	2.701e-001	3.051e-001
0.4	2.974e-001	3.709e-001	2.639e-001	2.635e-001	2.949e-001
0.5	2.787e-001	3.415e-001	2.456e-001	2.525e-001	2.782e-001
0.75	2.199e-001	2.568e-001	1.870e-001	2.167e-001	2.212e-001
1	1.721e-001	2.003e-001	1.472e-001	1.669e-001	1.758e-001
1.5	1.218e-001	1.432e-001	9.969e-002	1.280e-001	1.176e-001
2	9.221e-002	1.048e-001	7.702e-002	9.994e-002	8.786e-002
3	6.207e-002	6.773e-002	5.643e-002	6.880e-002	5.534e-002
4	4.396e-002	4.932e-002	4.294e-002	4.857e-002	3.503e-002
5	3.184e-002	3.837e-002	3.222e-002	3.433e-002	2.245e-002
7.5	1.606e-002	2.366e-002	1.565e-002	1.559e-002	9.331e-003
10	9.531e-003	1.702e-002	8.350e-003	7.891e-003	4.860e-003

Source: Great Salt Lake fault zone, Promontory secti [2369a]
Region: USGS 2014 Utah
Closest Distance: 51.87 km
Amplitude Units: Acceleration (g)
Magnitude: 7.09 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.430e-001	1.597e-001	1.572e-001	1.229e-001	1.321e-001
0.02	1.433e-001	1.618e-001	1.548e-001	1.245e-001	1.321e-001
0.03	1.473e-001	1.655e-001	1.597e-001	1.279e-001	1.360e-001
0.05	1.682e-001	1.860e-001	1.845e-001	1.462e-001	1.563e-001
0.075	2.082e-001	2.261e-001	2.266e-001	1.808e-001	1.992e-001
0.1	2.508e-001	2.781e-001	2.594e-001	2.247e-001	2.409e-001

0.15	3.185e-001	3.994e-001	3.167e-001	2.620e-001	2.959e-001
0.2	3.656e-001	4.663e-001	3.608e-001	2.969e-001	3.383e-001
0.25	3.876e-001	4.842e-001	3.725e-001	3.298e-001	3.639e-001
0.3	3.953e-001	4.814e-001	3.714e-001	3.574e-001	3.712e-001
0.4	3.760e-001	4.598e-001	3.380e-001	3.469e-001	3.591e-001
0.5	3.521e-001	4.228e-001	3.153e-001	3.313e-001	3.389e-001
0.75	2.776e-001	3.144e-001	2.415e-001	2.845e-001	2.699e-001
1	2.163e-001	2.437e-001	1.887e-001	2.183e-001	2.147e-001
1.5	1.506e-001	1.728e-001	1.231e-001	1.627e-001	1.439e-001
2	1.109e-001	1.232e-001	9.173e-002	1.235e-001	1.053e-001
3	7.082e-002	7.563e-002	6.356e-002	8.045e-002	6.366e-002
4	4.843e-002	5.362e-002	4.651e-002	5.447e-002	3.913e-002
5	3.430e-002	4.108e-002	3.390e-002	3.775e-002	2.444e-002
7.5	1.661e-002	2.448e-002	1.555e-002	1.668e-002	9.733e-003
10	9.534e-003	1.679e-002	7.884e-003	8.568e-003	4.894e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	9.614e-002	1.057e-001	1.058e-001	8.290e-002	9.010e-002
0.02	9.622e-002	1.072e-001	1.038e-001	8.379e-002	9.004e-002
0.03	9.855e-002	1.100e-001	1.063e-001	8.568e-002	9.223e-002
0.05	1.117e-001	1.238e-001	1.201e-001	9.702e-002	1.057e-001
0.075	1.373e-001	1.508e-001	1.453e-001	1.185e-001	1.346e-001
0.1	1.653e-001	1.857e-001	1.665e-001	1.467e-001	1.624e-001
0.15	2.114e-001	2.671e-001	2.075e-001	1.724e-001	1.984e-001
0.2	2.439e-001	3.116e-001	2.417e-001	1.963e-001	2.258e-001
0.25	2.587e-001	3.227e-001	2.515e-001	2.189e-001	2.417e-001
0.3	2.629e-001	3.191e-001	2.516e-001	2.354e-001	2.456e-001
0.4	2.485e-001	3.027e-001	2.282e-001	2.269e-001	2.362e-001
0.5	2.311e-001	2.773e-001	2.102e-001	2.149e-001	2.218e-001
0.75	1.799e-001	2.048e-001	1.582e-001	1.813e-001	1.752e-001
1	1.394e-001	1.577e-001	1.227e-001	1.385e-001	1.385e-001
1.5	9.660e-002	1.112e-001	7.998e-002	1.030e-001	9.223e-002
2	7.099e-002	7.883e-002	5.935e-002	7.843e-002	6.733e-002
3	4.527e-002	4.848e-002	4.085e-002	5.105e-002	4.068e-002
4	3.104e-002	3.447e-002	2.978e-002	3.487e-002	2.502e-002
5	2.196e-002	2.639e-002	2.170e-002	2.409e-002	1.564e-002
7.5	1.064e-002	1.569e-002	1.002e-002	1.062e-002	6.242e-003
10	6.120e-003	1.074e-002	5.138e-003	5.461e-003	3.143e-003

Source: Wasatch fault, Provo section [2351g]
Region: USGS 2014 Utah
Closest Distance: 53.14 km
Amplitude Units: Acceleration (g)
Magnitude: 7.27 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.593e-001	1.753e-001	1.752e-001	1.346e-001	1.520e-001
0.02	1.596e-001	1.774e-001	1.723e-001	1.364e-001	1.522e-001
0.03	1.637e-001	1.809e-001	1.775e-001	1.403e-001	1.561e-001
0.05	1.861e-001	2.023e-001	2.040e-001	1.596e-001	1.785e-001
0.075	2.288e-001	2.447e-001	2.489e-001	1.951e-001	2.266e-001
0.1	2.740e-001	3.001e-001	2.824e-001	2.401e-001	2.735e-001
0.15	3.459e-001	4.321e-001	3.407e-001	2.754e-001	3.354e-001
0.2	3.978e-001	5.075e-001	3.871e-001	3.130e-001	3.837e-001
0.25	4.237e-001	5.308e-001	4.001e-001	3.503e-001	4.138e-001
0.3	4.345e-001	5.316e-001	4.001e-001	3.833e-001	4.231e-001
0.4	4.168e-001	5.142e-001	3.667e-001	3.752e-001	4.111e-001
0.5	3.930e-001	4.762e-001	3.447e-001	3.619e-001	3.894e-001
0.75	3.136e-001	3.599e-001	2.665e-001	3.164e-001	3.118e-001
1	2.461e-001	2.818e-001	2.103e-001	2.432e-001	2.492e-001
1.5	1.743e-001	2.021e-001	1.414e-001	1.857e-001	1.678e-001
2	1.296e-001	1.453e-001	1.077e-001	1.420e-001	1.232e-001
3	8.392e-002	9.064e-002	7.712e-002	9.327e-002	7.466e-002
4	5.830e-002	6.498e-002	5.799e-002	6.381e-002	4.644e-002
5	4.185e-002	5.027e-002	4.314e-002	4.448e-002	2.949e-002
7.5	2.098e-002	3.107e-002	2.058e-002	2.015e-002	1.212e-002
10	1.238e-002	2.236e-002	1.074e-002	1.020e-002	6.238e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014

Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.072e-001	1.162e-001	1.179e-001	9.092e-002	1.039e-001
0.02	1.073e-001	1.177e-001	1.156e-001	9.198e-002	1.039e-001
0.03	1.097e-001	1.204e-001	1.181e-001	9.415e-002	1.061e-001
0.05	1.237e-001	1.349e-001	1.328e-001	1.062e-001	1.211e-001
0.075	1.512e-001	1.636e-001	1.597e-001	1.281e-001	1.536e-001
0.1	1.811e-001	2.009e-001	1.813e-001	1.571e-001	1.850e-001
0.15	2.301e-001	2.898e-001	2.233e-001	1.816e-001	2.257e-001
0.2	2.659e-001	3.400e-001	2.593e-001	2.074e-001	2.569e-001
0.25	2.833e-001	3.545e-001	2.701e-001	2.329e-001	2.757e-001
0.3	2.894e-001	3.531e-001	2.710e-001	2.529e-001	2.807e-001
0.4	2.758e-001	3.390e-001	2.475e-001	2.457e-001	2.710e-001
0.5	2.582e-001	3.127e-001	2.298e-001	2.350e-001	2.554e-001
0.75	2.034e-001	2.348e-001	1.745e-001	2.016e-001	2.027e-001
1	1.587e-001	1.825e-001	1.368e-001	1.544e-001	1.610e-001
1.5	1.118e-001	1.301e-001	9.185e-002	1.176e-001	1.076e-001
2	8.292e-002	9.302e-002	6.970e-002	9.017e-002	7.878e-002
3	5.364e-002	5.810e-002	4.957e-002	5.919e-002	4.771e-002
4	3.736e-002	4.177e-002	3.713e-002	4.085e-002	2.970e-002
5	2.679e-002	3.229e-002	2.762e-002	2.839e-002	1.888e-002
7.5	1.345e-002	1.992e-002	1.326e-002	1.283e-002	7.770e-003
10	7.951e-003	1.430e-002	6.996e-003	6.503e-003	4.006e-003

Source: West Cache fault, Wellsville section [2521c]
Region: USGS 2014 Utah
Closest Distance: 65.56 km
Amplitude Units: Acceleration (g)
Magnitude: 6.60 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	8.253e-002	9.191e-002	9.396e-002	7.793e-002	7.217e-002
0.02	8.273e-002	9.325e-002	9.277e-002	7.869e-002	7.211e-002
0.03	8.523e-002	9.625e-002	9.589e-002	8.073e-002	7.424e-002
0.05	9.785e-002	1.097e-001	1.110e-001	9.342e-002	8.576e-002
0.075	1.225e-001	1.344e-001	1.384e-001	1.183e-001	1.095e-001
0.1	1.500e-001	1.654e-001	1.632e-001	1.509e-001	1.320e-001
0.15	1.934e-001	2.348e-001	2.081e-001	1.816e-001	1.617e-001
0.2	2.232e-001	2.719e-001	2.412e-001	2.066e-001	1.857e-001
0.25	2.368e-001	2.803e-001	2.504e-001	2.289e-001	2.001e-001
0.3	2.404e-001	2.734e-001	2.491e-001	2.466e-001	2.044e-001
0.4	2.245e-001	2.561e-001	2.239e-001	2.308e-001	1.978e-001
0.5	2.071e-001	2.322e-001	2.049e-001	2.144e-001	1.862e-001
0.75	1.591e-001	1.618e-001	1.536e-001	1.811e-001	1.467e-001
1	1.202e-001	1.194e-001	1.165e-001	1.346e-001	1.155e-001
1.5	7.902e-002	8.046e-002	7.016e-002	9.255e-002	7.607e-002
2	5.548e-002	5.507e-002	4.871e-002	6.649e-002	5.390e-002
3	3.281e-002	3.105e-002	3.053e-002	4.023e-002	2.942e-002
4	2.100e-002	2.049e-002	2.072e-002	2.579e-002	1.698e-002
5	1.405e-002	1.481e-002	1.428e-002	1.708e-002	1.003e-002
7.5	6.223e-003	8.251e-003	5.888e-003	7.127e-003	3.626e-003
10	3.442e-003	5.484e-003	2.751e-003	3.835e-003	1.697e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	5.518e-002	6.028e-002	6.325e-002	5.220e-002	4.892e-002
0.02	5.522e-002	6.118e-002	6.225e-002	5.260e-002	4.883e-002
0.03	5.666e-002	6.325e-002	6.383e-002	5.368e-002	5.003e-002
0.05	6.445e-002	7.206e-002	7.224e-002	6.148e-002	5.753e-002
0.075	8.009e-002	8.831e-002	8.875e-002	7.687e-002	7.324e-002
0.1	9.791e-002	1.087e-001	1.048e-001	9.771e-002	8.798e-002
0.15	1.271e-001	1.545e-001	1.364e-001	1.185e-001	1.072e-001
0.2	1.475e-001	1.789e-001	1.616e-001	1.355e-001	1.225e-001
0.25	1.568e-001	1.842e-001	1.691e-001	1.509e-001	1.316e-001
0.3	1.588e-001	1.790e-001	1.688e-001	1.615e-001	1.340e-001
0.4	1.476e-001	1.669e-001	1.511e-001	1.504e-001	1.291e-001
0.5	1.352e-001	1.509e-001	1.366e-001	1.387e-001	1.211e-001
0.75	1.027e-001	1.045e-001	1.006e-001	1.152e-001	9.478e-002
1	7.718e-002	7.672e-002	7.579e-002	8.537e-002	7.426e-002
1.5	5.056e-002	5.146e-002	4.557e-002	5.860e-002	4.866e-002
2	3.545e-002	3.509e-002	3.152e-002	4.222e-002	3.442e-002
3	2.094e-002	1.983e-002	1.962e-002	2.553e-002	1.879e-002

4	1.344e-002	1.312e-002	1.327e-002	1.651e-002	1.086e-002
5	8.984e-003	9.477e-003	9.140e-003	1.090e-002	6.422e-003
7.5	3.982e-003	5.270e-003	3.793e-003	4.539e-003	2.325e-003
10	2.205e-003	3.494e-003	1.793e-003	2.444e-003	1.090e-003

Source: Stansbury fault zone [2395]
Region: USGS 2014 Utah
Closest Distance: 72.14 km
Amplitude Units: Acceleration (g)
Magnitude: 7.09 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.037e-001	1.135e-001	1.126e-001	9.179e-002	9.687e-002
0.02	1.038e-001	1.150e-001	1.106e-001	9.284e-002	9.673e-002
0.03	1.065e-001	1.182e-001	1.136e-001	9.526e-002	9.893e-002
0.05	1.210e-001	1.336e-001	1.289e-001	1.083e-001	1.132e-001
0.075	1.490e-001	1.623e-001	1.573e-001	1.329e-001	1.437e-001
0.1	1.797e-001	1.989e-001	1.816e-001	1.651e-001	1.732e-001
0.15	2.286e-001	2.853e-001	2.256e-001	1.913e-001	2.124e-001
0.2	2.646e-001	3.359e-001	2.610e-001	2.177e-001	2.436e-001
0.25	2.838e-001	3.529e-001	2.733e-001	2.461e-001	2.631e-001
0.3	2.920e-001	3.536e-001	2.749e-001	2.700e-001	2.698e-001
0.4	2.802e-001	3.459e-001	2.524e-001	2.597e-001	2.628e-001
0.5	2.641e-001	3.236e-001	2.357e-001	2.477e-001	2.493e-001
0.75	2.097e-001	2.426e-001	1.810e-001	2.150e-001	2.003e-001
1	1.624e-001	1.871e-001	1.405e-001	1.617e-001	1.604e-001
1.5	1.134e-001	1.326e-001	9.121e-002	1.204e-001	1.093e-001
2	8.293e-002	9.441e-002	6.726e-002	8.963e-002	8.044e-002
3	5.273e-002	5.774e-002	4.626e-002	5.778e-002	4.915e-002
4	3.600e-002	4.095e-002	3.393e-002	3.881e-002	3.030e-002
5	2.543e-002	3.140e-002	2.476e-002	2.661e-002	1.894e-002
7.5	1.256e-002	1.927e-002	1.145e-002	1.196e-002	7.551e-003
10	7.339e-003	1.355e-002	5.804e-003	6.210e-003	3.797e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	6.954e-002	7.492e-002	7.580e-002	6.161e-002	6.585e-002
0.02	6.951e-002	7.595e-002	7.421e-002	6.219e-002	6.568e-002
0.03	7.104e-002	7.821e-002	7.560e-002	6.348e-002	6.685e-002
0.05	8.000e-002	8.843e-002	8.391e-002	7.147e-002	7.620e-002
0.075	9.786e-002	1.075e-001	1.009e-001	8.660e-002	9.649e-002
0.1	1.179e-001	1.317e-001	1.166e-001	1.072e-001	1.160e-001
0.15	1.509e-001	1.893e-001	1.478e-001	1.251e-001	1.414e-001
0.2	1.756e-001	2.229e-001	1.748e-001	1.432e-001	1.615e-001
0.25	1.886e-001	2.338e-001	1.845e-001	1.626e-001	1.737e-001
0.3	1.935e-001	2.332e-001	1.862e-001	1.771e-001	1.776e-001
0.4	1.847e-001	2.270e-001	1.704e-001	1.694e-001	1.721e-001
0.5	1.729e-001	2.117e-001	1.571e-001	1.603e-001	1.626e-001
0.75	1.357e-001	1.577e-001	1.185e-001	1.368e-001	1.297e-001
1	1.046e-001	1.209e-001	9.142e-002	1.026e-001	1.034e-001
1.5	7.266e-002	8.521e-002	5.924e-002	7.622e-002	6.997e-002
2	5.305e-002	6.039e-002	4.352e-002	5.691e-002	5.139e-002
3	3.371e-002	3.701e-002	2.974e-002	3.667e-002	3.141e-002
4	2.307e-002	2.633e-002	2.172e-002	2.484e-002	1.937e-002
5	1.628e-002	2.017e-002	1.585e-002	1.698e-002	1.213e-002
7.5	8.048e-003	1.235e-002	7.379e-003	7.617e-003	4.842e-003
10	4.710e-003	8.663e-003	3.782e-003	3.958e-003	2.438e-003

Source: Bear River fault zone [730]
Region: USGS 2014 Wyoming
Closest Distance: 72.48 km
Amplitude Units: Acceleration (g)
Magnitude: 6.90 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6

PGA	9.185e-002	9.807e-002	1.025e-001	8.283e-002	8.398e-002
0.02	9.198e-002	9.944e-002	1.009e-001	8.372e-002	8.388e-002
0.03	9.455e-002	1.025e-001	1.038e-001	8.591e-002	8.597e-002
0.05	1.080e-001	1.163e-001	1.186e-001	9.831e-002	9.879e-002
0.075	1.339e-001	1.419e-001	1.459e-001	1.222e-001	1.258e-001
0.1	1.623e-001	1.743e-001	1.699e-001	1.533e-001	1.516e-001
0.15	2.072e-001	2.489e-001	2.136e-001	1.804e-001	1.857e-001
0.2	2.393e-001	2.915e-001	2.476e-001	2.050e-001	2.130e-001
0.25	2.557e-001	3.043e-001	2.586e-001	2.300e-001	2.298e-001
0.3	2.619e-001	3.028e-001	2.592e-001	2.502e-001	2.353e-001
0.4	2.492e-001	2.933e-001	2.363e-001	2.387e-001	2.285e-001
0.5	2.331e-001	2.727e-001	2.189e-001	2.248e-001	2.161e-001
0.75	1.831e-001	2.007e-001	1.666e-001	1.932e-001	1.721e-001
1	1.406e-001	1.530e-001	1.282e-001	1.441e-001	1.369e-001
1.5	9.610e-002	1.072e-001	8.079e-002	1.043e-001	9.217e-002
2	6.923e-002	7.545e-002	5.817e-002	7.643e-002	6.687e-002
3	4.288e-002	4.518e-002	3.858e-002	4.804e-002	3.971e-002
4	2.859e-002	3.140e-002	2.746e-002	3.166e-002	2.386e-002
5	1.970e-002	2.320e-002	1.960e-002	2.139e-002	1.461e-002
7.5	9.303e-003	1.356e-002	8.674e-003	9.357e-003	5.616e-003
10	5.329e-003	9.376e-003	4.258e-003	4.932e-003	2.748e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	6.153e-002	6.458e-002	6.902e-002	5.552e-002	5.701e-002
0.02	6.152e-002	6.551e-002	6.769e-002	5.601e-002	5.687e-002
0.03	6.298e-002	6.762e-002	6.912e-002	5.717e-002	5.801e-002
0.05	7.128e-002	7.677e-002	7.721e-002	6.476e-002	6.638e-002
0.075	8.775e-002	9.365e-002	9.357e-002	7.947e-002	8.431e-002
0.1	1.062e-001	1.150e-001	1.091e-001	9.936e-002	1.013e-001
0.15	1.364e-001	1.646e-001	1.399e-001	1.178e-001	1.233e-001
0.2	1.585e-001	1.927e-001	1.658e-001	1.346e-001	1.408e-001
0.25	1.697e-001	2.009e-001	1.746e-001	1.517e-001	1.514e-001
0.3	1.733e-001	1.991e-001	1.756e-001	1.640e-001	1.545e-001
0.4	1.641e-001	1.920e-001	1.595e-001	1.556e-001	1.493e-001
0.5	1.525e-001	1.779e-001	1.459e-001	1.454e-001	1.407e-001
0.75	1.184e-001	1.302e-001	1.091e-001	1.229e-001	1.113e-001
1	9.040e-002	9.866e-002	8.339e-002	9.141e-002	8.815e-002
1.5	6.156e-002	6.877e-002	5.248e-002	6.602e-002	5.899e-002
2	4.427e-002	4.821e-002	3.764e-002	4.853e-002	4.271e-002
3	2.740e-002	2.893e-002	2.480e-002	3.048e-002	2.537e-002
4	1.832e-002	2.017e-002	1.758e-002	2.027e-002	1.526e-002
5	1.261e-002	1.489e-002	1.255e-002	1.365e-002	9.352e-003
7.5	5.959e-003	8.688e-003	5.588e-003	5.960e-003	3.601e-003
10	3.418e-003	5.990e-003	2.775e-003	3.144e-003	1.765e-003

Source: West Cache fault zone, Junction Hills fault [2521b]
Region: USGS 2014 Utah
Closest Distance: 78.34 km
Amplitude Units: Acceleration (g)
Magnitude: 6.70 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	7.235e-002	7.699e-002	8.057e-002	6.873e-002	6.355e-002
0.02	7.245e-002	7.809e-002	7.938e-002	6.937e-002	6.342e-002
0.03	7.449e-002	8.067e-002	8.171e-002	7.110e-002	6.496e-002
0.05	8.517e-002	9.195e-002	9.313e-002	8.159e-002	7.459e-002
0.075	1.060e-001	1.123e-001	1.151e-001	1.023e-001	9.481e-002
0.1	1.293e-001	1.379e-001	1.359e-001	1.300e-001	1.141e-001
0.15	1.660e-001	1.959e-001	1.743e-001	1.553e-001	1.398e-001
0.2	1.925e-001	2.287e-001	2.040e-001	1.773e-001	1.610e-001
0.25	2.059e-001	2.383e-001	2.141e-001	1.981e-001	1.743e-001
0.3	2.108e-001	2.359e-001	2.149e-001	2.144e-001	1.791e-001
0.4	1.998e-001	2.277e-001	1.954e-001	2.025e-001	1.746e-001
0.5	1.863e-001	2.109e-001	1.801e-001	1.894e-001	1.655e-001
0.75	1.452e-001	1.518e-001	1.362e-001	1.615e-001	1.320e-001
1	1.104e-001	1.139e-001	1.038e-001	1.194e-001	1.049e-001
1.5	7.395e-002	7.851e-002	6.348e-002	8.380e-002	7.029e-002
2	5.233e-002	5.450e-002	4.451e-002	6.001e-002	5.050e-002
3	3.131e-002	3.107e-002	2.838e-002	3.666e-002	2.925e-002
4	2.027e-002	2.072e-002	1.958e-002	2.364e-002	1.714e-002
5	1.368e-002	1.510e-002	1.367e-002	1.568e-002	1.026e-002
7.5	6.232e-003	8.669e-003	5.784e-003	6.688e-003	3.787e-003
10	3.509e-003	5.906e-003	2.742e-003	3.589e-003	1.800e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	4.836e-002	5.050e-002	5.424e-002	4.598e-002	4.303e-002
0.02	4.835e-002	5.124e-002	5.326e-002	4.631e-002	4.290e-002
0.03	4.950e-002	5.301e-002	5.439e-002	4.721e-002	4.372e-002
0.05	5.605e-002	6.038e-002	6.062e-002	5.361e-002	4.997e-002
0.075	6.919e-002	7.372e-002	7.384e-002	6.638e-002	6.329e-002
0.1	8.427e-002	9.045e-002	8.724e-002	8.406e-002	7.588e-002
0.15	1.090e-001	1.287e-001	1.142e-001	1.012e-001	9.245e-002
0.2	1.271e-001	1.503e-001	1.367e-001	1.161e-001	1.061e-001
0.25	1.363e-001	1.565e-001	1.446e-001	1.304e-001	1.145e-001
0.3	1.392e-001	1.544e-001	1.456e-001	1.403e-001	1.172e-001
0.4	1.314e-001	1.485e-001	1.319e-001	1.318e-001	1.138e-001
0.5	1.217e-001	1.371e-001	1.200e-001	1.224e-001	1.075e-001
0.75	9.372e-002	9.816e-002	8.922e-002	1.027e-001	8.523e-002
1	7.090e-002	7.322e-002	6.752e-002	7.573e-002	6.741e-002
1.5	4.733e-002	5.026e-002	4.123e-002	5.305e-002	4.496e-002
2	3.344e-002	3.476e-002	2.880e-002	3.810e-002	3.224e-002
3	1.999e-002	1.986e-002	1.824e-002	2.326e-002	1.869e-002
4	1.298e-002	1.328e-002	1.254e-002	1.513e-002	1.096e-002
5	8.749e-003	9.673e-003	8.748e-003	1.001e-002	6.566e-003
7.5	3.989e-003	5.543e-003	3.726e-003	4.260e-003	2.429e-003
10	2.249e-003	3.766e-003	1.787e-003	2.288e-003	1.156e-003

Source: Hansel Valley fault [2358]
Region: USGS 2014 Utah
Closest Distance: 89.90 km
Amplitude Units: Acceleration (g)
Magnitude: 6.60 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	5.957e-002	6.447e-002	6.433e-002	5.547e-002	5.402e-002
0.02	5.963e-002	6.536e-002	6.338e-002	5.590e-002	5.389e-002
0.03	6.119e-002	6.753e-002	6.513e-002	5.714e-002	5.496e-002
0.05	6.950e-002	7.688e-002	7.361e-002	6.478e-002	6.272e-002
0.075	8.617e-002	9.342e-002	9.105e-002	8.104e-002	7.917e-002
0.1	1.054e-001	1.142e-001	1.090e-001	1.038e-001	9.481e-002
0.15	1.365e-001	1.617e-001	1.423e-001	1.262e-001	1.159e-001
0.2	1.594e-001	1.896e-001	1.674e-001	1.464e-001	1.344e-001
0.25	1.720e-001	1.990e-001	1.771e-001	1.653e-001	1.464e-001
0.3	1.769e-001	1.967e-001	1.787e-001	1.811e-001	1.512e-001
0.4	1.683e-001	1.906e-001	1.633e-001	1.707e-001	1.487e-001
0.5	1.572e-001	1.764e-001	1.504e-001	1.600e-001	1.418e-001
0.75	1.225e-001	1.242e-001	1.139e-001	1.381e-001	1.138e-001
1	9.272e-002	9.145e-002	8.649e-002	1.023e-001	9.063e-002
1.5	6.143e-002	6.177e-002	5.220e-002	7.088e-002	6.088e-002
2	4.279e-002	4.221e-002	3.613e-002	4.934e-002	4.347e-002
3	2.487e-002	2.340e-002	2.257e-002	2.963e-002	2.390e-002
4	1.567e-002	1.527e-002	1.534e-002	1.856e-002	1.349e-002
5	1.037e-002	1.097e-002	1.059e-002	1.206e-002	7.918e-003
7.5	4.651e-003	6.292e-003	4.385e-003	5.106e-003	2.853e-003
10	2.604e-003	4.284e-003	2.041e-003	2.790e-003	1.336e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	3.977e-002	4.220e-002	4.331e-002	3.704e-002	3.654e-002
0.02	3.974e-002	4.280e-002	4.253e-002	3.724e-002	3.641e-002
0.03	4.061e-002	4.426e-002	4.335e-002	3.786e-002	3.695e-002
0.05	4.567e-002	5.034e-002	4.792e-002	4.246e-002	4.195e-002
0.075	5.618e-002	6.112e-002	5.838e-002	5.246e-002	5.275e-002
0.1	6.859e-002	7.465e-002	6.984e-002	6.692e-002	6.293e-002
0.15	8.937e-002	1.059e-001	9.304e-002	8.201e-002	7.653e-002
0.2	1.051e-001	1.243e-001	1.121e-001	9.568e-002	8.834e-002
0.25	1.136e-001	1.303e-001	1.196e-001	1.086e-001	9.593e-002
0.3	1.167e-001	1.284e-001	1.211e-001	1.183e-001	9.884e-002
0.4	1.105e-001	1.240e-001	1.102e-001	1.110e-001	9.683e-002

0.5	1.025e-001	1.145e-001	1.003e-001	1.034e-001	9.205e-002
0.75	7.901e-002	8.018e-002	7.460e-002	8.783e-002	7.341e-002
1	5.952e-002	5.870e-002	5.627e-002	6.486e-002	5.824e-002
1.5	3.930e-002	3.949e-002	3.391e-002	4.487e-002	3.892e-002
2	2.734e-002	2.689e-002	2.338e-002	3.133e-002	2.775e-002
3	1.588e-002	1.494e-002	1.451e-002	1.880e-002	1.527e-002
4	1.003e-002	9.780e-003	9.824e-003	1.188e-002	8.629e-003
5	6.632e-003	7.023e-003	6.778e-003	7.695e-003	5.068e-003
7.5	2.976e-003	4.019e-003	2.825e-003	3.252e-003	1.830e-003
10	1.668e-003	2.729e-003	1.330e-003	1.779e-003	8.582e-004

Source: Eastern Bear Lake fault [2364abc]
Region: USGS 2014 Idaho
Closest Distance: 91.43 km
Amplitude Units: Acceleration (g)
Magnitude: 7.29 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	9.242e-002	1.007e-001	9.834e-002	7.923e-002	9.144e-002
0.02	9.236e-002	1.019e-001	9.624e-002	8.014e-002	9.116e-002
0.03	9.428e-002	1.046e-001	9.819e-002	8.202e-002	9.232e-002
0.05	1.056e-001	1.177e-001	1.088e-001	9.171e-002	1.043e-001
0.075	1.282e-001	1.414e-001	1.309e-001	1.096e-001	1.310e-001
0.1	1.536e-001	1.720e-001	1.513e-001	1.340e-001	1.573e-001
0.15	1.952e-001	2.473e-001	1.887e-001	1.524e-001	1.923e-001
0.2	2.282e-001	2.960e-001	2.193e-001	1.757e-001	2.217e-001
0.25	2.492e-001	3.178e-001	2.333e-001	2.042e-001	2.414e-001
0.3	2.604e-001	3.241e-001	2.378e-001	2.299e-001	2.498e-001
0.4	2.559e-001	3.298e-001	2.226e-001	2.245e-001	2.467e-001
0.5	2.453e-001	3.160e-001	2.103e-001	2.184e-001	2.367e-001
0.75	1.994e-001	2.434e-001	1.641e-001	1.961e-001	1.939e-001
1	1.558e-001	1.892e-001	1.286e-001	1.477e-001	1.576e-001
1.5	1.114e-001	1.358e-001	8.608e-002	1.139e-001	1.100e-001
2	8.254e-002	9.799e-002	6.490e-002	8.499e-002	8.227e-002
3	5.373e-002	6.123e-002	4.626e-002	5.575e-002	5.170e-002
4	3.741e-002	4.414e-002	3.507e-002	3.788e-002	3.256e-002
5	2.684e-002	3.424e-002	2.623e-002	2.612e-002	2.078e-002
7.5	1.397e-002	2.227e-002	1.279e-002	1.226e-002	8.580e-003
10	8.547e-003	1.673e-002	6.708e-003	6.324e-003	4.432e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	6.195e-002	6.638e-002	6.620e-002	5.308e-002	6.212e-002
0.02	6.181e-002	6.721e-002	6.457e-002	5.359e-002	6.185e-002
0.03	6.284e-002	6.910e-002	6.536e-002	5.455e-002	6.234e-002
0.05	6.978e-002	7.775e-002	7.082e-002	6.037e-002	7.016e-002
0.075	8.411e-002	9.342e-002	8.390e-002	7.125e-002	8.786e-002
0.1	1.006e-001	1.136e-001	9.692e-002	8.679e-002	1.051e-001
0.15	1.285e-001	1.636e-001	1.233e-001	9.947e-002	1.278e-001
0.2	1.512e-001	1.960e-001	1.469e-001	1.153e-001	1.467e-001
0.25	1.654e-001	2.101e-001	1.575e-001	1.347e-001	1.591e-001
0.3	1.724e-001	2.136e-001	1.611e-001	1.506e-001	1.642e-001
0.4	1.686e-001	2.163e-001	1.502e-001	1.463e-001	1.614e-001
0.5	1.606e-001	2.067e-001	1.402e-001	1.413e-001	1.543e-001
0.75	1.290e-001	1.583e-001	1.075e-001	1.248e-001	1.255e-001
1	1.003e-001	1.222e-001	8.365e-002	9.369e-002	1.015e-001
1.5	7.143e-002	8.727e-002	5.591e-002	7.211e-002	7.043e-002
2	5.280e-002	6.268e-002	4.199e-002	5.397e-002	5.257e-002
3	3.435e-002	3.924e-002	2.973e-002	3.538e-002	3.304e-002
4	2.398e-002	2.837e-002	2.245e-002	2.425e-002	2.082e-002
5	1.719e-002	2.199e-002	1.679e-002	1.667e-002	1.330e-002
7.5	8.956e-003	1.428e-002	8.239e-003	7.806e-003	5.502e-003
10	5.486e-003	1.069e-002	4.371e-003	4.031e-003	2.846e-003

Source: North Promontory fault [2361]
Region: USGS 2014 Nevada
Closest Distance: 96.75 km
Amplitude Units: Acceleration (g)
Magnitude: 6.73 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations

Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	5.575e-002	5.851e-002	6.212e-002	5.153e-002	5.086e-002
0.02	5.576e-002	5.929e-002	6.109e-002	5.198e-002	5.067e-002
0.03	5.708e-002	6.124e-002	6.257e-002	5.306e-002	5.144e-002
0.05	6.449e-002	6.964e-002	6.985e-002	6.012e-002	5.837e-002
0.075	7.940e-002	8.430e-002	8.593e-002	7.401e-002	7.336e-002
0.1	9.664e-002	1.027e-001	1.026e-001	9.342e-002	8.780e-002
0.15	1.248e-001	1.458e-001	1.342e-001	1.116e-001	1.074e-001
0.2	1.464e-001	1.725e-001	1.587e-001	1.295e-001	1.248e-001
0.25	1.587e-001	1.829e-001	1.681e-001	1.476e-001	1.363e-001
0.3	1.647e-001	1.839e-001	1.709e-001	1.627e-001	1.413e-001
0.4	1.595e-001	1.837e-001	1.578e-001	1.566e-001	1.399e-001
0.5	1.509e-001	1.738e-001	1.465e-001	1.491e-001	1.341e-001
0.75	1.197e-001	1.272e-001	1.121e-001	1.307e-001	1.090e-001
1	9.159e-002	9.567e-002	8.571e-002	9.732e-002	8.767e-002
1.5	6.219e-002	6.650e-002	5.284e-002	6.940e-002	6.002e-002
2	4.418e-002	4.653e-002	3.714e-002	4.943e-002	4.362e-002
3	2.668e-002	2.678e-002	2.376e-002	3.021e-002	2.598e-002
4	1.733e-002	1.797e-002	1.650e-002	1.947e-002	1.539e-002
5	1.170e-002	1.313e-002	1.156e-002	1.286e-002	9.255e-003
7.5	5.415e-003	7.716e-003	4.945e-003	5.559e-003	3.442e-003
10	3.088e-003	5.359e-003	2.351e-003	2.996e-003	1.644e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	3.723e-002	3.834e-002	4.182e-002	3.438e-002	3.439e-002
0.02	3.717e-002	3.887e-002	4.099e-002	3.462e-002	3.423e-002
0.03	3.788e-002	4.019e-002	4.165e-002	3.513e-002	3.457e-002
0.05	4.237e-002	4.563e-002	4.547e-002	3.938e-002	3.902e-002
0.075	5.173e-002	5.518e-002	5.503e-002	4.787e-002	4.884e-002
0.1	6.283e-002	6.719e-002	6.566e-002	6.021e-002	5.823e-002
0.15	8.160e-002	9.556e-002	8.751e-002	7.245e-002	7.087e-002
0.2	9.642e-002	1.131e-001	1.060e-001	8.457e-002	8.201e-002
0.25	1.049e-001	1.198e-001	1.135e-001	9.693e-002	8.929e-002
0.3	1.086e-001	1.202e-001	1.158e-001	1.062e-001	9.235e-002
0.4	1.048e-001	1.197e-001	1.065e-001	1.018e-001	9.102e-002
0.5	9.847e-002	1.129e-001	9.765e-002	9.631e-002	8.702e-002
0.75	7.726e-002	8.223e-002	7.341e-002	8.308e-002	7.031e-002
1	5.882e-002	6.149e-002	5.576e-002	6.169e-002	5.633e-002
1.5	3.980e-002	4.257e-002	3.432e-002	4.393e-002	3.837e-002
2	2.824e-002	2.968e-002	2.403e-002	3.139e-002	2.784e-002
3	1.704e-002	1.712e-002	1.527e-002	1.917e-002	1.659e-002
4	1.110e-002	1.152e-002	1.056e-002	1.247e-002	9.838e-003
5	7.487e-003	8.415e-003	7.402e-003	8.207e-003	5.924e-003
7.5	3.467e-003	4.935e-003	3.186e-003	3.540e-003	2.207e-003
10	1.979e-003	3.418e-003	1.532e-003	1.910e-003	1.055e-003

Source: Strawberry fault [2412]
Region: USGS 2014 Utah
Closest Distance: 97.12 km
Amplitude Units: Acceleration (g)
Magnitude: 6.92 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	6.430e-002	6.854e-002	7.017e-002	5.764e-002	6.085e-002
0.02	6.428e-002	6.943e-002	6.888e-002	5.820e-002	6.061e-002
0.03	6.571e-002	7.158e-002	7.041e-002	5.942e-002	6.143e-002
0.05	7.396e-002	8.113e-002	7.819e-002	6.692e-002	6.958e-002
0.075	9.053e-002	9.791e-002	9.545e-002	8.139e-002	8.737e-002
0.1	1.096e-001	1.192e-001	1.129e-001	1.016e-001	1.046e-001
0.15	1.408e-001	1.700e-001	1.458e-001	1.194e-001	1.280e-001
0.2	1.652e-001	2.022e-001	1.718e-001	1.385e-001	1.482e-001
0.25	1.798e-001	2.158e-001	1.822e-001	1.593e-001	1.618e-001
0.3	1.873e-001	2.185e-001	1.857e-001	1.772e-001	1.677e-001
0.4	1.827e-001	2.205e-001	1.726e-001	1.717e-001	1.660e-001
0.5	1.739e-001	2.100e-001	1.613e-001	1.650e-001	1.593e-001
0.75	1.394e-001	1.570e-001	1.244e-001	1.462e-001	1.301e-001
1	1.075e-001	1.194e-001	9.592e-002	1.094e-001	1.053e-001
1.5	7.448e-002	8.398e-002	6.081e-002	8.021e-002	7.290e-002

2	5.374e-002	5.943e-002	4.375e-002	5.799e-002	5.376e-002
3	3.349e-002	3.576e-002	2.902e-002	3.632e-002	3.286e-002
4	2.243e-002	2.515e-002	2.076e-002	2.383e-002	1.997e-002
5	1.544e-002	1.863e-002	1.488e-002	1.597e-002	1.228e-002
7.5	7.430e-003	1.121e-002	6.658e-003	7.106e-003	4.746e-003
10	4.330e-003	7.939e-003	3.273e-003	3.778e-003	2.331e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	4.299e-002	4.505e-002	4.724e-002	3.850e-002	4.119e-002
0.02	4.291e-002	4.565e-002	4.621e-002	3.879e-002	4.099e-002
0.03	4.368e-002	4.712e-002	4.687e-002	3.938e-002	4.134e-002
0.05	4.868e-002	5.335e-002	5.090e-002	4.388e-002	4.658e-002
0.075	5.911e-002	6.432e-002	6.113e-002	5.271e-002	5.827e-002
0.1	7.138e-002	7.823e-002	7.223e-002	6.554e-002	6.953e-002
0.15	9.224e-002	1.118e-001	9.502e-002	7.760e-002	8.456e-002
0.2	1.090e-001	1.331e-001	1.147e-001	9.056e-002	9.757e-002
0.25	1.190e-001	1.419e-001	1.230e-001	1.047e-001	1.061e-001
0.3	1.236e-001	1.433e-001	1.258e-001	1.158e-001	1.098e-001
0.4	1.201e-001	1.441e-001	1.165e-001	1.117e-001	1.082e-001
0.5	1.136e-001	1.369e-001	1.075e-001	1.066e-001	1.035e-001
0.75	9.004e-002	1.017e-001	8.148e-002	9.294e-002	8.400e-002
1	6.909e-002	7.694e-002	6.240e-002	6.935e-002	6.767e-002
1.5	4.770e-002	5.388e-002	3.950e-002	5.078e-002	4.663e-002
2	3.436e-002	3.798e-002	2.831e-002	3.682e-002	3.433e-002
3	2.140e-002	2.291e-002	1.865e-002	2.305e-002	2.100e-002
4	1.437e-002	1.616e-002	1.329e-002	1.526e-002	1.277e-002
5	9.884e-003	1.196e-002	9.525e-003	1.019e-002	7.861e-003
7.5	4.760e-003	7.182e-003	4.289e-003	4.526e-003	3.043e-003
10	2.778e-003	5.073e-003	2.133e-003	2.408e-003	1.497e-003

Source: Wasatch fault, Nephi section [2351h]
Region: USGS 2014 Utah
Closest Distance: 100.28 km
Amplitude Units: Acceleration (g)
Magnitude: 7.01 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	6.639e-002	7.068e-002	7.204e-002	5.850e-002	6.435e-002
0.02	6.635e-002	7.157e-002	7.063e-002	5.909e-002	6.409e-002
0.03	6.774e-002	7.372e-002	7.210e-002	6.031e-002	6.482e-002
0.05	7.598e-002	8.338e-002	7.971e-002	6.760e-002	7.322e-002
0.075	9.261e-002	1.003e-001	9.686e-002	8.150e-002	9.175e-002
0.1	1.117e-001	1.219e-001	1.141e-001	1.011e-001	1.098e-001
0.15	1.433e-001	1.741e-001	1.469e-001	1.179e-001	1.342e-001
0.2	1.686e-001	2.082e-001	1.734e-001	1.372e-001	1.554e-001
0.25	1.842e-001	2.235e-001	1.845e-001	1.589e-001	1.699e-001
0.3	1.925e-001	2.274e-001	1.879e-001	1.781e-001	1.765e-001
0.4	1.890e-001	2.317e-001	1.756e-001	1.737e-001	1.751e-001
0.5	1.808e-001	2.221e-001	1.647e-001	1.681e-001	1.685e-001
0.75	1.460e-001	1.677e-001	1.277e-001	1.505e-001	1.382e-001
1	1.131e-001	1.282e-001	9.890e-002	1.129e-001	1.122e-001
1.5	7.911e-002	9.071e-002	6.358e-002	8.397e-002	7.820e-002
2	5.745e-002	6.456e-002	4.625e-002	6.099e-002	5.799e-002
3	3.619e-002	3.926e-002	3.120e-002	3.853e-002	3.578e-002
4	2.447e-002	2.782e-002	2.264e-002	2.545e-002	2.196e-002
5	1.711e-002	2.125e-002	1.640e-002	1.713e-002	1.364e-002
7.5	8.402e-003	1.300e-002	7.502e-003	7.743e-003	5.365e-003
10	4.953e-003	9.303e-003	3.747e-003	4.094e-003	2.669e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	4.442e-002	4.651e-002	4.849e-002	3.908e-002	4.358e-002
0.02	4.431e-002	4.711e-002	4.739e-002	3.939e-002	4.336e-002
0.03	4.505e-002	4.858e-002	4.799e-002	3.998e-002	4.363e-002
0.05	5.003e-002	5.489e-002	5.188e-002	4.433e-002	4.904e-002
0.075	6.050e-002	6.598e-002	6.201e-002	5.279e-002	6.122e-002

0.1	7.284e-002	8.010e-002	7.302e-002	6.522e-002	7.300e-002
0.15	9.393e-002	1.147e-001	9.571e-002	7.664e-002	8.871e-002
0.2	1.112e-001	1.372e-001	1.157e-001	8.972e-002	1.024e-001
0.25	1.219e-001	1.472e-001	1.244e-001	1.045e-001	1.115e-001
0.3	1.271e-001	1.493e-001	1.273e-001	1.164e-001	1.155e-001
0.4	1.243e-001	1.516e-001	1.185e-001	1.130e-001	1.142e-001
0.5	1.182e-001	1.449e-001	1.098e-001	1.086e-001	1.095e-001
0.75	9.435e-002	1.088e-001	8.366e-002	9.570e-002	8.923e-002
1	7.269e-002	8.270e-002	6.434e-002	7.157e-002	7.214e-002
1.5	5.068e-002	5.824e-002	4.130e-002	5.316e-002	5.002e-002
2	3.674e-002	4.129e-002	2.992e-002	3.872e-002	3.704e-002
3	2.313e-002	2.516e-002	2.005e-002	2.445e-002	2.286e-002
4	1.568e-002	1.789e-002	1.450e-002	1.629e-002	1.404e-002
5	1.095e-002	1.365e-002	1.050e-002	1.093e-002	8.731e-003
7.5	5.384e-003	8.332e-003	4.833e-003	4.932e-003	3.440e-003
10	3.178e-003	5.949e-003	2.442e-003	2.609e-003	1.714e-003

Source: West Cache fault, Clarkston section [2521a]
Region: USGS 2014 Utah
Closest Distance: 101.67 km
Amplitude Units: Acceleration (g)
Magnitude: 6.66 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	4.955e-002	5.293e-002	5.517e-002	4.562e-002	4.565e-002
0.02	4.955e-002	5.362e-002	5.427e-002	4.600e-002	4.546e-002
0.03	5.065e-002	5.537e-002	5.555e-002	4.688e-002	4.603e-002
0.05	5.701e-002	6.288e-002	6.188e-002	5.302e-002	5.200e-002
0.075	7.002e-002	7.584e-002	7.617e-002	6.524e-002	6.504e-002
0.1	8.536e-002	9.216e-002	9.152e-002	8.259e-002	7.761e-002
0.15	1.109e-001	1.306e-001	1.211e-001	9.936e-002	9.493e-002
0.2	1.309e-001	1.548e-001	1.442e-001	1.165e-001	1.108e-001
0.25	1.428e-001	1.649e-001	1.535e-001	1.336e-001	1.216e-001
0.3	1.483e-001	1.656e-001	1.555e-001	1.482e-001	1.268e-001
0.4	1.441e-001	1.657e-001	1.440e-001	1.426e-001	1.264e-001
0.5	1.364e-001	1.565e-001	1.336e-001	1.360e-001	1.218e-001
0.75	1.083e-001	1.129e-001	1.022e-001	1.200e-001	9.952e-002
1	8.264e-002	8.385e-002	7.803e-002	8.956e-002	8.024e-002
1.5	5.572e-002	5.751e-002	4.769e-002	6.330e-002	5.505e-002
2	3.920e-002	3.983e-002	3.324e-002	4.431e-002	3.989e-002
3	2.328e-002	2.257e-002	2.097e-002	2.678e-002	2.302e-002
4	1.499e-002	1.507e-002	1.440e-002	1.711e-002	1.340e-002
5	1.005e-002	1.095e-002	1.002e-002	1.122e-002	7.995e-003
7.5	4.590e-003	6.404e-003	4.217e-003	4.807e-003	2.931e-003
10	2.601e-003	4.431e-003	1.979e-003	2.609e-003	1.386e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	3.307e-002	3.465e-002	3.714e-002	3.041e-002	3.085e-002
0.02	3.301e-002	3.511e-002	3.642e-002	3.060e-002	3.069e-002
0.03	3.359e-002	3.628e-002	3.698e-002	3.101e-002	3.091e-002
0.05	3.742e-002	4.114e-002	4.026e-002	3.469e-002	3.473e-002
0.075	4.558e-002	4.956e-002	4.875e-002	4.216e-002	4.325e-002
0.1	5.543e-002	6.017e-002	5.853e-002	5.318e-002	5.142e-002
0.15	7.240e-002	8.540e-002	7.883e-002	6.446e-002	6.255e-002
0.2	8.610e-002	1.013e-001	9.611e-002	7.602e-002	7.272e-002
0.25	9.417e-002	1.079e-001	1.034e-001	8.765e-002	7.961e-002
0.3	9.776e-002	1.081e-001	1.054e-001	9.668e-002	8.276e-002
0.4	9.455e-002	1.078e-001	9.716e-002	9.263e-002	8.219e-002
0.5	8.899e-002	1.015e-001	8.904e-002	8.778e-002	7.897e-002
0.75	6.983e-002	7.288e-002	6.697e-002	7.629e-002	6.417e-002
1	5.305e-002	5.384e-002	5.076e-002	5.676e-002	5.154e-002
1.5	3.565e-002	3.679e-002	3.097e-002	4.007e-002	3.519e-002
2	2.505e-002	2.539e-002	2.151e-002	2.814e-002	2.546e-002
3	1.486e-002	1.442e-002	1.348e-002	1.699e-002	1.471e-002
4	9.599e-003	9.655e-003	9.224e-003	1.095e-002	8.567e-003
5	6.426e-003	7.014e-003	6.413e-003	7.159e-003	5.117e-003
7.5	2.938e-003	4.093e-003	2.716e-003	3.062e-003	1.880e-003
10	1.667e-003	2.825e-003	1.290e-003	1.663e-003	8.897e-004

Source: Rock Creek fault [729]
Region: USGS 2014 Wyoming

Closest Distance: 114.89 km
Amplitude Units: Acceleration (g)
Magnitude: 6.95 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	5.236e-002	5.521e-002	5.719e-002	4.549e-002	5.153e-002
0.02	5.224e-002	5.586e-002	5.591e-002	4.591e-002	5.126e-002
0.03	5.315e-002	5.753e-002	5.692e-002	4.668e-002	5.149e-002
0.05	5.917e-002	6.495e-002	6.230e-002	5.180e-002	5.762e-002
0.075	7.155e-002	7.754e-002	7.527e-002	6.185e-002	7.154e-002
0.1	8.626e-002	9.361e-002	8.962e-002	7.660e-002	8.520e-002
0.15	1.114e-001	1.335e-001	1.179e-001	9.016e-002	1.040e-001
0.2	1.327e-001	1.610e-001	1.418e-001	1.065e-001	1.214e-001
0.25	1.467e-001	1.750e-001	1.531e-001	1.250e-001	1.338e-001
0.3	1.547e-001	1.799e-001	1.570e-001	1.417e-001	1.402e-001
0.4	1.540e-001	1.876e-001	1.476e-001	1.399e-001	1.409e-001
0.5	1.487e-001	1.821e-001	1.390e-001	1.369e-001	1.369e-001
0.75	1.212e-001	1.380e-001	1.082e-001	1.248e-001	1.138e-001
1	9.391e-002	1.050e-001	8.338e-002	9.406e-002	9.323e-002
1.5	6.586e-002	7.417e-002	5.336e-002	7.005e-002	6.585e-002
2	4.767e-002	5.278e-002	3.854e-002	5.033e-002	4.904e-002
3	2.989e-002	3.196e-002	2.567e-002	3.153e-002	3.041e-002
4	2.009e-002	2.263e-002	1.847e-002	2.067e-002	1.859e-002
5	1.389e-002	1.696e-002	1.330e-002	1.380e-002	1.148e-002
7.5	6.775e-003	1.040e-002	6.010e-003	6.222e-003	4.468e-003
10	3.993e-003	7.479e-003	2.968e-003	3.321e-003	2.205e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	3.497e-002	3.627e-002	3.844e-002	3.033e-002	3.485e-002
0.02	3.485e-002	3.671e-002	3.751e-002	3.055e-002	3.462e-002
0.03	3.530e-002	3.784e-002	3.787e-002	3.088e-002	3.460e-002
0.05	3.888e-002	4.265e-002	4.046e-002	3.389e-002	3.851e-002
0.075	4.663e-002	5.085e-002	4.811e-002	3.997e-002	4.761e-002
0.1	5.609e-002	6.132e-002	5.720e-002	4.932e-002	5.649e-002
0.15	7.280e-002	8.759e-002	7.653e-002	5.849e-002	6.858e-002
0.2	8.726e-002	1.058e-001	9.405e-002	6.949e-002	7.973e-002
0.25	9.677e-002	1.150e-001	1.025e-001	8.200e-002	8.761e-002
0.3	1.019e-001	1.178e-001	1.057e-001	9.246e-002	9.158e-002
0.4	1.011e-001	1.225e-001	9.925e-002	9.091e-002	9.171e-002
0.5	9.705e-002	1.187e-001	9.233e-002	8.839e-002	8.880e-002
0.75	7.822e-002	8.939e-002	7.071e-002	7.933e-002	7.345e-002
1	6.035e-002	6.762e-002	5.424e-002	5.962e-002	5.992e-002
1.5	4.217e-002	4.759e-002	3.466e-002	4.434e-002	4.211e-002
2	3.048e-002	3.373e-002	2.494e-002	3.195e-002	3.131e-002
3	1.910e-002	2.048e-002	1.650e-002	2.001e-002	1.943e-002
4	1.287e-002	1.454e-002	1.182e-002	1.323e-002	1.189e-002
5	8.889e-003	1.089e-002	8.511e-003	8.808e-003	7.351e-003
7.5	4.341e-003	6.663e-003	3.872e-003	3.963e-003	2.865e-003
10	2.562e-003	4.780e-003	1.934e-003	2.117e-003	1.416e-003

Source: Wasatch fault, Levan section [2351i]
Region: USGS 2014 Utah
Closest Distance: 149.91 km
Amplitude Units: Acceleration (g)
Magnitude: 6.83 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	3.079e-002	3.186e-002	3.394e-002	2.642e-002	3.094e-002
0.02	3.064e-002	3.216e-002	3.312e-002	2.662e-002	3.067e-002
0.03	3.085e-002	3.303e-002	3.333e-002	2.679e-002	3.024e-002
0.05	3.340e-002	3.692e-002	3.475e-002	2.900e-002	3.291e-002
0.075	3.946e-002	4.305e-002	4.127e-002	3.377e-002	3.975e-002
0.1	4.745e-002	5.106e-002	5.031e-002	4.170e-002	4.673e-002
0.15	6.235e-002	7.247e-002	6.984e-002	5.010e-002	5.700e-002
0.2	7.678e-002	8.964e-002	8.804e-002	6.142e-002	6.800e-002
0.25	8.767e-002	1.009e-001	9.883e-002	7.420e-002	7.675e-002

0.3	9.494e-002	1.065e-001	1.043e-001	8.647e-002	8.242e-002
0.4	9.844e-002	1.182e-001	1.011e-001	8.845e-002	8.598e-002
0.5	9.750e-002	1.186e-001	9.624e-002	8.930e-002	8.586e-002
0.75	8.170e-002	9.071e-002	7.658e-002	8.511e-002	7.442e-002
1	6.393e-002	6.837e-002	5.939e-002	6.553e-002	6.244e-002
1.5	4.524e-002	4.836e-002	3.782e-002	4.910e-002	4.569e-002
2	3.261e-002	3.447e-002	2.701e-002	3.450e-002	3.447e-002
3	2.033e-002	2.075e-002	1.764e-002	2.118e-002	2.175e-002
4	1.339e-002	1.430e-002	1.239e-002	1.365e-002	1.323e-002
5	9.080e-003	1.054e-002	8.753e-003	8.949e-003	8.083e-003
7.5	4.366e-003	6.524e-003	3.854e-003	4.008e-003	3.077e-003
10	2.568e-003	4.733e-003	1.868e-003	2.178e-003	1.493e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.047e-002	2.087e-002	2.258e-002	1.756e-002	2.087e-002
0.02	2.035e-002	2.107e-002	2.200e-002	1.766e-002	2.067e-002
0.03	2.040e-002	2.165e-002	2.199e-002	1.767e-002	2.027e-002
0.05	2.186e-002	2.414e-002	2.246e-002	1.891e-002	2.192e-002
0.075	2.562e-002	2.809e-002	2.629e-002	2.175e-002	2.635e-002
0.1	3.071e-002	3.327e-002	3.197e-002	2.676e-002	3.086e-002
0.15	4.053e-002	4.732e-002	4.498e-002	3.239e-002	3.743e-002
0.2	5.020e-002	5.861e-002	5.772e-002	3.996e-002	4.450e-002
0.25	5.746e-002	6.598e-002	6.524e-002	4.854e-002	5.008e-002
0.3	6.216e-002	6.952e-002	6.918e-002	5.628e-002	5.367e-002
0.4	6.429e-002	7.698e-002	6.701e-002	5.738e-002	5.580e-002
0.5	6.334e-002	7.704e-002	6.318e-002	5.759e-002	5.557e-002
0.75	5.255e-002	5.863e-002	4.957e-002	5.406e-002	4.794e-002
1	4.096e-002	4.396e-002	3.829e-002	4.152e-002	4.008e-002
1.5	2.891e-002	3.098e-002	2.438e-002	3.108e-002	2.920e-002
2	2.082e-002	2.200e-002	1.736e-002	2.190e-002	2.200e-002
3	1.297e-002	1.328e-002	1.125e-002	1.344e-002	1.390e-002
4	8.564e-003	9.175e-003	7.887e-003	8.737e-003	8.457e-003
5	5.806e-003	6.757e-003	5.581e-003	5.711e-003	5.174e-003
7.5	2.794e-003	4.176e-003	2.474e-003	2.553e-003	1.973e-003
10	1.645e-003	3.022e-003	1.210e-003	1.388e-003	9.589e-004

Source: Joes Valley fault zone [2455]
Region: USGS 2014 Utah
Closest Distance: 160.47 km
Amplitude Units: Acceleration (g)
Magnitude: 7.02 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	3.255e-002	3.388e-002	3.513e-002	2.696e-002	3.423e-002
0.02	3.236e-002	3.415e-002	3.420e-002	2.718e-002	3.389e-002
0.03	3.243e-002	3.499e-002	3.423e-002	2.731e-002	3.320e-002
0.05	3.474e-002	3.890e-002	3.502e-002	2.917e-002	3.585e-002
0.075	4.055e-002	4.494e-002	4.101e-002	3.322e-002	4.303e-002
0.1	4.838e-002	5.297e-002	4.968e-002	4.037e-002	5.049e-002
0.15	6.336e-002	7.549e-002	6.880e-002	4.773e-002	6.144e-002
0.2	7.861e-002	9.467e-002	8.742e-002	5.908e-002	7.329e-002
0.25	9.083e-002	1.084e-001	9.926e-002	7.268e-002	8.302e-002
0.3	9.948e-002	1.161e-001	1.059e-001	8.628e-002	8.964e-002
0.4	1.051e-001	1.325e-001	1.042e-001	8.972e-002	9.421e-002
0.5	1.056e-001	1.352e-001	1.002e-001	9.234e-002	9.468e-002
0.75	9.011e-002	1.061e-001	8.091e-002	9.024e-002	8.323e-002
1	7.124e-002	8.075e-002	6.344e-002	7.014e-002	7.063e-002
1.5	5.166e-002	5.786e-002	4.175e-002	5.430e-002	5.275e-002
2	3.785e-002	4.177e-002	3.059e-002	3.857e-002	4.049e-002
3	2.426e-002	2.575e-002	2.075e-002	2.419e-002	2.633e-002
4	1.645e-002	1.858e-002	1.498e-002	1.581e-002	1.641e-002
5	1.144e-002	1.422e-002	1.079e-002	1.049e-002	1.025e-002
7.5	5.754e-003	9.115e-003	4.983e-003	4.867e-003	4.054e-003
10	3.479e-003	6.768e-003	2.508e-003	2.618e-003	2.022e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.165e-002	2.224e-002	2.332e-002	1.793e-002	2.310e-002
0.02	2.149e-002	2.242e-002	2.266e-002	1.804e-002	2.285e-002
0.03	2.145e-002	2.299e-002	2.255e-002	1.802e-002	2.226e-002
0.05	2.275e-002	2.549e-002	2.262e-002	1.902e-002	2.389e-002
0.075	2.635e-002	2.938e-002	2.610e-002	2.140e-002	2.853e-002
0.1	3.135e-002	3.459e-002	3.154e-002	2.590e-002	3.335e-002
0.15	4.121e-002	4.940e-002	4.424e-002	3.086e-002	4.036e-002
0.2	5.140e-002	6.203e-002	5.716e-002	3.844e-002	4.797e-002
0.25	5.952e-002	7.102e-002	6.532e-002	4.755e-002	5.420e-002
0.3	6.511e-002	7.593e-002	6.997e-002	5.616e-002	5.839e-002
0.4	6.866e-002	8.645e-002	6.882e-002	5.821e-002	6.116e-002
0.5	6.862e-002	8.801e-002	6.561e-002	5.955e-002	6.131e-002
0.75	5.798e-002	6.870e-002	5.226e-002	5.733e-002	5.363e-002
1	4.565e-002	5.202e-002	4.081e-002	4.444e-002	4.535e-002
1.5	3.301e-002	3.713e-002	2.684e-002	3.437e-002	3.372e-002
2	2.416e-002	2.671e-002	1.959e-002	2.449e-002	2.584e-002
3	1.546e-002	1.651e-002	1.318e-002	1.535e-002	1.682e-002
4	1.052e-002	1.195e-002	9.511e-003	1.012e-002	1.050e-002
5	7.315e-003	9.134e-003	6.869e-003	6.695e-003	6.563e-003
7.5	3.684e-003	5.844e-003	3.193e-003	3.100e-003	2.599e-003
10	2.229e-003	4.328e-003	1.620e-003	1.669e-003	1.299e-003

Source: Grand Valley fault [726c]
Region: USGS 2014 Wyoming
Closest Distance: 178.09 km
Amplitude Units: Acceleration (g)
Magnitude: 7.10 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.895e-002	3.022e-002	3.081e-002	2.347e-002	3.131e-002
0.02	2.874e-002	3.042e-002	2.992e-002	2.366e-002	3.095e-002
0.03	2.863e-002	3.108e-002	2.975e-002	2.367e-002	3.000e-002
0.05	3.018e-002	3.430e-002	2.961e-002	2.486e-002	3.194e-002
0.075	3.469e-002	3.905e-002	3.416e-002	2.772e-002	3.782e-002
0.1	4.114e-002	4.558e-002	4.151e-002	3.331e-002	4.414e-002
0.15	5.408e-002	6.503e-002	5.837e-002	3.927e-002	5.364e-002
0.2	6.813e-002	8.294e-002	7.567e-002	4.946e-002	6.444e-002
0.25	8.011e-002	9.705e-002	8.762e-002	6.204e-002	7.374e-002
0.3	8.913e-002	1.059e-001	9.502e-002	7.510e-002	8.053e-002
0.4	9.669e-002	1.254e-001	9.542e-002	7.983e-002	8.607e-002
0.5	9.879e-002	1.307e-001	9.283e-002	8.396e-002	8.764e-002
0.75	8.600e-002	1.045e-001	7.629e-002	8.440e-002	7.880e-002
1	6.867e-002	7.981e-002	6.046e-002	6.651e-002	6.789e-002
1.5	5.074e-002	5.766e-002	4.071e-002	5.268e-002	5.192e-002
2	3.755e-002	4.198e-002	3.029e-002	3.748e-002	4.043e-002
3	2.445e-002	2.622e-002	2.094e-002	2.371e-002	2.693e-002
4	1.674e-002	1.914e-002	1.524e-002	1.558e-002	1.701e-002
5	1.171e-002	1.472e-002	1.104e-002	1.037e-002	1.073e-002
7.5	6.066e-003	9.850e-003	5.202e-003	4.901e-003	4.309e-003
10	3.725e-003	7.423e-003	2.667e-003	2.634e-003	2.175e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.923e-002	1.983e-002	2.037e-002	1.560e-002	2.112e-002
0.02	1.907e-002	1.997e-002	1.976e-002	1.569e-002	2.086e-002
0.03	1.891e-002	2.041e-002	1.954e-002	1.560e-002	2.011e-002
0.05	1.976e-002	2.246e-002	1.909e-002	1.620e-002	2.127e-002
0.075	2.253e-002	2.552e-002	2.171e-002	1.784e-002	2.506e-002
0.1	2.664e-002	2.974e-002	2.631e-002	2.136e-002	2.914e-002
0.15	3.514e-002	4.253e-002	3.743e-002	2.537e-002	3.522e-002
0.2	4.448e-002	5.432e-002	4.927e-002	3.216e-002	4.216e-002
0.25	5.241e-002	6.358e-002	5.737e-002	4.057e-002	4.811e-002
0.3	5.824e-002	6.922e-002	6.245e-002	4.887e-002	5.243e-002
0.4	6.305e-002	8.184e-002	6.272e-002	5.178e-002	5.585e-002
0.5	6.412e-002	8.510e-002	6.051e-002	5.413e-002	5.673e-002
0.75	5.529e-002	6.767e-002	4.910e-002	5.361e-002	5.077e-002
1	4.397e-002	5.141e-002	3.876e-002	4.213e-002	4.358e-002
1.5	3.240e-002	3.700e-002	2.606e-002	3.334e-002	3.319e-002
2	2.394e-002	2.684e-002	1.931e-002	2.380e-002	2.581e-002
3	1.557e-002	1.680e-002	1.323e-002	1.505e-002	1.720e-002
4	1.070e-002	1.230e-002	9.633e-003	9.972e-003	1.088e-002
5	7.486e-003	9.457e-003	7.004e-003	6.615e-003	6.867e-003
7.5	3.881e-003	6.315e-003	3.325e-003	3.122e-003	2.763e-003

10	2.385e-003	4.747e-003	1.716e-003	1.679e-003	1.396e-003

Source: Greys River fault [728]
Region: USGS 2014 Wyoming
Closest Distance: 193.11 km
Amplitude Units: Acceleration (g)
Magnitude: 7.05 Mw
Fractile: 0.84
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	2.359e-002	2.439e-002	2.515e-002	1.920e-002	2.563e-002
0.02	2.340e-002	2.452e-002	2.442e-002	1.935e-002	2.530e-002
0.03	2.319e-002	2.500e-002	2.416e-002	1.927e-002	2.431e-002
0.05	2.414e-002	2.743e-002	2.355e-002	2.004e-002	2.554e-002
0.075	2.745e-002	3.086e-002	2.695e-002	2.212e-002	2.986e-002
0.1	3.249e-002	3.571e-002	3.306e-002	2.653e-002	3.465e-002
0.15	4.302e-002	5.089e-002	4.754e-002	3.159e-002	4.208e-002
0.2	5.500e-002	6.568e-002	6.286e-002	4.040e-002	5.105e-002
0.25	6.561e-002	7.812e-002	7.402e-002	5.123e-002	5.908e-002
0.3	7.391e-002	8.635e-002	8.134e-002	6.269e-002	6.526e-002
0.4	8.171e-002	1.053e-001	8.290e-002	6.771e-002	7.098e-002
0.5	8.447e-002	1.113e-001	8.119e-002	7.214e-002	7.322e-002
0.75	7.450e-002	8.947e-002	6.753e-002	7.387e-002	6.710e-002
1	5.980e-002	6.813e-002	5.382e-002	5.880e-002	5.847e-002
1.5	4.445e-002	4.928e-002	3.637e-002	4.671e-002	4.545e-002
2	3.290e-002	3.593e-002	2.705e-002	3.298e-002	3.562e-002
3	2.140e-002	2.242e-002	1.857e-002	2.071e-002	2.391e-002
4	1.459e-002	1.639e-002	1.336e-002	1.352e-002	1.508e-002
5	1.014e-002	1.258e-002	9.590e-003	8.935e-003	9.473e-003
7.5	5.187e-003	8.301e-003	4.467e-003	4.207e-003	3.773e-003
10	3.177e-003	6.268e-003	2.274e-003	2.275e-003	1.892e-003

Fractile: Mean
Column 1: Spectral Period
Column 2: Acceleration (g) for: Weighted Mean of Attenuation Equations
Column 3: Acceleration (g) for: Abrahamson-et al (2014) NGA West 2 USGS 2014
Column 4: Acceleration (g) for: Boore-et al (2014) NGA West 2 USGS 2014
Column 5: Acceleration (g) for: Campbell-Bozorgnia (2014) NGA West 2 USGS 2014
Column 6: Acceleration (g) for: Chiou-Youngs (2014) NGA West 2 USGS 2014

1	2	3	4	5	6
PGA	1.565e-002	1.600e-002	1.658e-002	1.276e-002	1.728e-002
0.02	1.551e-002	1.609e-002	1.608e-002	1.282e-002	1.704e-002
0.03	1.531e-002	1.641e-002	1.583e-002	1.270e-002	1.628e-002
0.05	1.579e-002	1.795e-002	1.516e-002	1.305e-002	1.700e-002
0.075	1.781e-002	2.015e-002	1.712e-002	1.423e-002	1.977e-002
0.1	2.102e-002	2.328e-002	2.093e-002	1.700e-002	2.284e-002
0.15	2.791e-002	3.325e-002	3.042e-002	2.040e-002	2.760e-002
0.2	3.585e-002	4.298e-002	4.080e-002	2.625e-002	3.337e-002
0.25	4.285e-002	5.114e-002	4.828e-002	3.348e-002	3.851e-002
0.3	4.822e-002	5.641e-002	5.324e-002	4.077e-002	4.245e-002
0.4	5.321e-002	6.864e-002	5.428e-002	4.390e-002	4.602e-002
0.5	5.476e-002	7.244e-002	5.276e-002	4.650e-002	4.736e-002
0.75	4.785e-002	5.793e-002	4.335e-002	4.691e-002	4.321e-002
1	3.826e-002	4.387e-002	3.440e-002	3.725e-002	3.752e-002
1.5	2.836e-002	3.162e-002	2.321e-002	2.956e-002	2.904e-002
2	2.096e-002	2.297e-002	1.718e-002	2.094e-002	2.273e-002
3	1.362e-002	1.437e-002	1.169e-002	1.314e-002	1.528e-002
4	9.313e-003	1.054e-002	8.419e-003	8.652e-003	9.641e-003
5	6.479e-003	8.078e-003	6.073e-003	5.702e-003	6.063e-003
7.5	3.318e-003	5.322e-003	2.849e-003	2.679e-003	2.419e-003
10	2.033e-003	4.008e-003	1.459e-003	1.450e-003	1.215e-003

APPENDIX B

SEISMIC VELOCITY SURVEY RESULTS
GMHA SUMMARY
OSHPD REPORT

Intermountain GeoEnvironmental Services, Inc.
2702 South 1030 West, Suite 10, South Salt Lake, Utah 84119
(801) 270-9400

17 June 2024

Andrew Harris, P.E.
CMT Technical Services
2796 South Redwood Road
West Vally, UT 84119
Andy.Harris@CMTTechnical.com
(801) 870-6730

RE: SEISMIC VELOCITY SURVEY (V_{S100}) –DFCM Facility, Lagoon Drive, Farmington, UT

Based on the project objective of determining seismic site classification, IGES conducted a shear wave velocity survey at the DFCM Facility site located west of the State Liquor & Wine Store on Lagoon Drive in Farmington, UT (Figure 1). The survey details the shear wave velocity profile of the near surface to a depth of 100 ft.

Seismic Shear Wave Velocity Survey

Seismic Surface Waves methods such as MASW (Multichannel Analysis of Surface Waves), MAM (Microtremor Array Measurements), and ReMi (Refraction Microtremor) use the dispersive characteristics of surface waves to determine the variation of the seismic shear wave velocity with depth. Velocity data are derived by analyzing seismic surface waves generated by a controlled impulse or by random ambient sources and received by an array of geophones. The ambient MAM data is supplemented with 10 minutes of hammer blows to produce a smooth broad-spectrum curve.

The recording parameters used for the survey are shown in Table 1 with the approximate location shown in Figure 1. The V_{S100} sounding is centered at approximately 40.990147°, -111.900208°.

Figure A1 shows the dispersion curve of the data from the Vs_{100} with phase velocity (ft/s) of the surface wave as a function of frequency (Hz). Figure A2 shows the shear wave velocity profile (a 1-D sounding of velocity as a function of depth) modeled from the dispersion curve. The average shear wave velocity for the near-surface is calculated to be 777.3 ft/s.

Table 1: Shear wave velocity survey recording parameters.

Test location	DFCM Facility
Test date	06/13/2024
Recording instrument	Summit II Compact
S/N	SUX1018
Geophone natural period	4.5 Hz
Geophone/station spacing	16.4 feet
Number of channels	24
Spread length / geometry	377 feet
Sample rate	4 milliseconds
Number of samples	15,000/trace
Record length	60 seconds
Total recording time / records	30 minutes
Low pass filter	½ Nyquist
Low cut filter	1 Hz.
Seismic source	12 lb. hammer (10 minutes)
Source location	-30 foot offset
Analysis software	SeisImager™ Geometrics, Inc.

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Figure 1: Approximate locations of the shear wave velocity (V_{S100}) survey at the DFCM Facility site. The test array length is 377 ft.

Limitations

The concept of risk is a significant consideration of geophysical analyses. The analytical means and methods used in performing geophysical analyses and development of resulting data set does not constitute an exact science. Analytical tools used by geophysicists are based on limited data, empirical correlations, judgment, and experience. As such the solutions and resulting data set presented in this report cannot be considered risk-free and constitute IGES's best professional opinion based on the available data at the time they were developed. IGES has developed the preceding analyses, at a minimum, in accordance with generally accepted professional geophysical practices and care being exercised in the project area at the time our services were performed. No warranties, guarantees, or other representations are made.

The information contained in this report is based on limited field testing and understanding of the project. The data used in the preparation of this report were obtained by IGES for this project. Variations in the soil, rock, and groundwater conditions likely exist between and beyond the points explored. The nature and extent of the variations may not be evident until construction occurs and/or additional explorations are completed.

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This report was prepared for our client's exclusive use on the project identified in the foregoing. Use of the data contained herein for any other project described in this report is at the user's sole risk. It is the client's responsibility to see that all parties to the project including the designer, contractor, subcontractors, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

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We trust you will find this report acceptable and look forward to discussing the project with you in more detail if necessary. If you have any questions regarding the work or any other aspects of our report, please contact the undersigned at your earliest convenience at (801) 270-9400.

Sincerely,
IGES, Inc.



Yanni Philopoulos
Geophysicist

Attachments:
Appendix A

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APPENDIX A

Shear Wave Velocity Soundings

Microtremor Array Measurement (MAM)

(Depth is measured in feet below ground surface. Velocity is reported in feet per second.)

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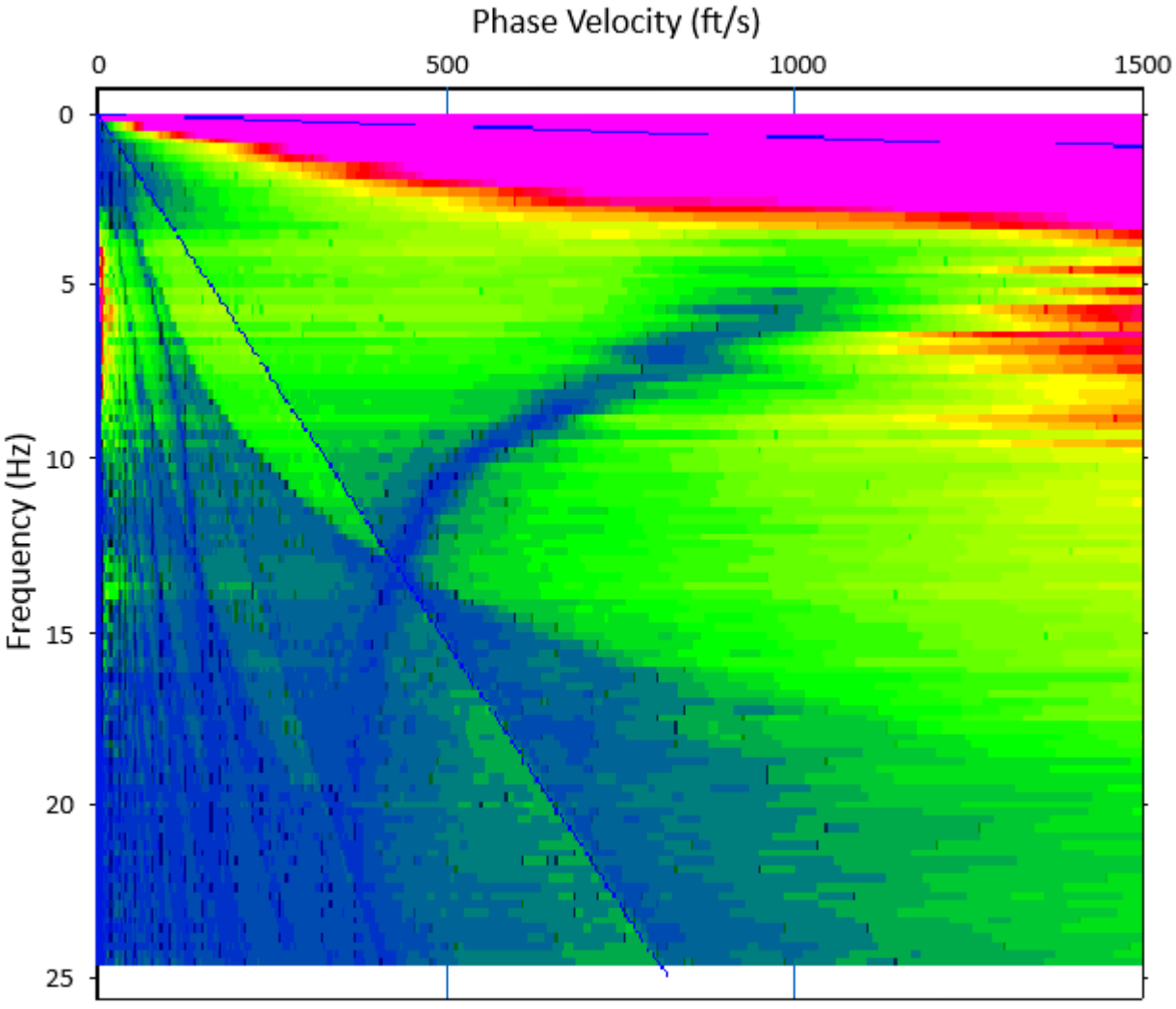


Figure A2: Dispersion curve of the V_{S100} showing phase velocity (ft/s) as a function of frequency (Hz).

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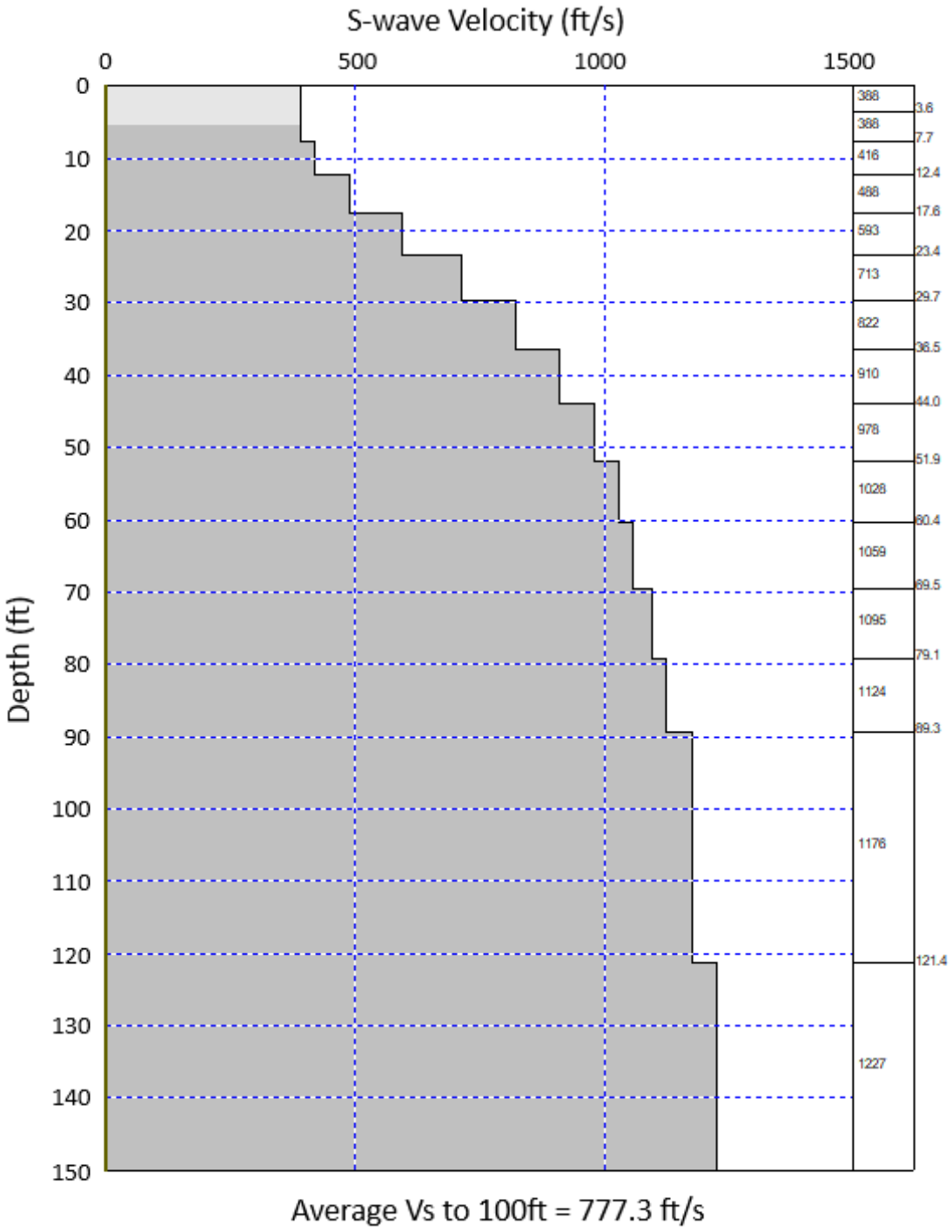


Figure A3: Shear wave velocity profile (a 1-D sounding of velocity as a function of depth) of the V_{S100} modeled from the dispersion curve. The shear velocity of the near surface is calculated to be 777.3 ft/s.

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Project: **Farmington Regional Center**
Project No: **22203**
Performed By: **Bill Turner**
Checked By: **Andy Harris**

Design Standards:

IBC 2021
ASCE 7-16
ASCE 7-16 Supplement 1

Outcomes:

Site-Specific Ground Motion Hazard Analysis performed according to ASCE 7-16 Section 21.2, using *EZ-FRISK* (ver. 8.06) software and NGA-2West Spreadsheet.

Input Information:

Geophysical Survey Report (attached, provides estimated $V_{s,30}$ for the site)

Boring Logs from CMT Geotechnical Engineering Study (report dated January 10, 2023)

Table 1.5-1 Risk Category of Buildings and Other Structures for Flood, Wind, Snow, Earthquake, and Ice Loads

Use or Occupancy of Buildings and Structures	Risk Category
Buildings and other structures that represent low risk to human life in the event of failure	I
All buildings and other structures except those listed in Risk Categories I, III, and IV	II
Buildings and other structures, the failure of which could pose a substantial risk to human life	III
Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure	
Buildings and other structures not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where the quantity of the material exceeds a threshold quantity established by the Authority Having Jurisdiction and is sufficient to pose a threat to the public if released[a]	
Buildings and other structures designated as essential facilities	IV
Buildings and other structures, the failure of which could pose a substantial hazard to the community Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity of the material exceeds a threshold quantity established by the Authority Having Jurisdiction and is sufficient to pose a threat to the public if released[a]	
Buildings and other structures required to maintain the functionality of other Risk Category IV structures	

Site Location (approximate center of site for estimating seismic source distances):

Latitude: **40.9904**
Longitude: **-111.9005**

Risk Category: **II**
Prelim. Site Class: **D**

S_s & S_1 are obtained in accordance with ASCE 7-16 Section 11.4.2 using the latest available USGS database [from online web tool www.seismicmaps.org by Structural Engineers Association of California (SEAOC) and California's Office of Statewide Health Planning and Development (OSHPD) - see attached]

S_s: **1.338**
S_1: **0.494**
PGA: **0.611**
PGA_M: **0.673**
T_L: **8**
C_{RS}: **0.864**
C_{R1}: **0.882**

Determine Site Classification in accordance with ASCE 7-16 Chapter 20.3:

20.3.1 Site Class F. Where any of the following conditions is satisfied, the site shall be classified as Site Class F and a site response analysis in accordance with Section 21.1 shall be performed.

1. Soils vulnerable to potential failure or collapse under seismic loading, such as liquefiable soils, quick and highly sensitive clays, and collapsible weakly cemented soils.
   EXCEPTION: For structures that have fundamental periods of vibration equal to or less than 0.5 s, site response analysis is not required to determine spectral accelerations for liquefiable soils. Rather, a site class is permitted to be determined in accordance with Section 20.3 and the corresponding values of F_a and F_v determined from Tables 11.4-1 and 11.4-2.
2. Peats and/or highly organic clays [$H > 10$ ft ($H > 3$ m)] of peat and/or highly organic clay where H = thickness of soil.
3. Very high plasticity clays [$H > 25$ ft ($H > 7.6$ m) with $PI > 75$] in a soil profile that would otherwise be classified as Site Class D or E.
   EXCEPTION: Site response analysis is not required for this clay category provided that both of the following requirements are satisfied: (i) values of F_a and F_v are obtained from Tables 11.4-1 and 11.4-2 for Site Class D or E multiplied by a factor that varies linearly from 1.0 at $PI = 75$ to 1.3 for $PI = 125$ and is equal to 1.3 for $PI > 125$; and (ii) the resulting values of S_{DS} and S_{D1} obtained using the scaled factors F_a and F_v do not exceed the upper bound values for Seismic Design Category B given in Tables 11.6-1 and 11.6-2.
4. Very thick soft/medium stiff clays [$H > 120$ ft ($H > 37$ m)] with $s_u < 1{,}000$ psf ($s_u < 50$ kPa).
   EXCEPTION: Site response analysis is not required for this clay category provided that both of the following requirements are satisfied: (i) values of F_a and F_v are obtained from Tables 11.4-1 and 11.4-2 for Site Class E; and (ii) the resulting values of S_{DS} and S_{D1} using the factors F_a and F_v do not exceed the upper bound values for Seismic Design Category B given in Tables 11.6-1 and 11.6-2.

20.3.2 Soft Clay Site Class E. Where a site does not qualify under the criteria for Site Class F and there is a total thickness of soft clay greater than 10 ft (3 m) where a soft clay layer is defined by $s_u < 500$ psf ($s_u < 25$ kPa), $w \geq 40\%$, and $PI > 20$, it shall be classified as Site Class E.

20.3.3 Site Classes C, D, and E. The existence of Site Class C, D, and E soils shall be classified by using one of the following three methods with $\bar{v}_s$, $\bar{N}$, and $\bar{s}_u$ computed in all cases as specified in Section 20.4:

1. $\bar{v}_s$ for the top 100 ft (30 m) ($\bar{v}_s$ method).
2. $\bar{N}$ for the top 100 ft (30 m) ($\bar{N}$ method).
3. $\bar{N}_{ch}$ for cohesionless soil layers ($PI < 20$) in the top 100 ft (30 m) and $\bar{s}_u$ for cohesive soil layers ($PI > 20$) in the top 100 ft (30 m) ($\bar{s}_u$ method). Where the $\bar{N}_{ch}$ and $\bar{s}_u$ criteria differ, the site shall be assigned to the category with the softer soil.

Determine whether the site classifies as Site Class F:

inputs:

1. Are the subsurface soils:

Liquefiable?	no
Quick or highly sensitive clays?	no
Collapsible weakly cemented?	no
Is the structure's fundamental period of vibration equal to or less than 0.5 seconds?	N/A

2. Are peat and/or highly organic clay layers > 10 ft thick present? **no**

3. Are very high plasticity clays > 25 ft thick and PI>75 present? **no**

If yes, enter the plasticity index: **N/A**

PI factor= 1

Scaled Fa = 1 * 1 = 1

Scaled Fv = 2.5 * 1 = 2.5

Resulting S_{DS} = 0.892 > 0.33

Resulting S_{D1} = 0.823 > 0.133

Can Exception be applied? **NO**

4. Are clays with s_u < 1,000 psf thicker than 120 ft present? **no**

F_a = 1

F_v = 4

Resulting S_{DS} = 0.892 > 0.33

Resulting S_{D1} = 1.317 > 0.133

Can Exception be applied? **NO**

Does the site classify as Site Class F? ***NO***

Determine Site Class:

See if more than 10' of soft clay is present:

Enter s_u for >10' of soft clay (psf):	
Enter moisture % for >10' of soft clay:	
Enter PI for >10' of soft clay:	
Enter weighted avg. v_s in upper 100 feet (ft/sec):	777
Enter weighted avg. blow count in upper 100 ft:	
Enter weighted avg. blow count of cohesionless layers having PI < 20 in upper 100 ft:	
Enter weighted avg. s_u for cohesive soil layers having PI > 20 in upper 100 feet:	
Are there more than 10 feet of soils below bottom of foundations to rock?	yes

Results: ***Site Class =*** **D** **w/data**

Table 20.3-1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50 blows/ft	>2,000 lb/ft^2
D. Stiff soil	600 to 1,200 ft/s	15 to 50 blows/ft	1,000 to 2,000 lb/ft^2
E. Soft clay soil	<600 ft/s	<15 blows/ft	<1,000 lb/ft^2
	Any profile with more than 10 ft of soil that has the following characteristics: — Plasticity index $PI > 20$, — Moisture content $w \geq 40\%$, — Undrained shear strength $\bar{s}_u < 500$ lb/ft^2		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

Note: For SI: 1 ft = 0.3048 m; 1 ft/s = 0.3048 m/s; 1 lb/ft^2 = 0.0479 kN/m^2.

Check Requirements for Ground Motion Hazard Analysis

Site Class: D

Is Site Response Analysis Required? ***NO***

Put no if don't know the answers to the 2 questions below:

Will the structure be seismically isolated? **no**

Will the structure have a damping system? **no**

Is S_1 greater than or equal to 0.6? **NO**

Is S_s greater than or equal to 1.0? **YES**

Is S_1 greater than or equal to 0.2? **YES**

Is Ground Motion Hazard Analysis Required? ***YES***

NOTE that the EXCEPTION values (as listed in Section 11.4.8 at left) may be used instead of performing a GMHA at the site.

11.4.8 Site-Specific Ground Motion Procedures. A site response analysis shall be performed in accordance with Section 21.1 for structures on Site Class F sites, unless exempted in accordance with Section 20.3.1. A ground motion hazard analysis shall be performed in accordance with Section 21.2 for the following:

1. seismically isolated structures and structures with damping systems on sites with S_1 greater than or equal to 0.6,
2. structures on Site Class E sites with S_s greater than or equal to 1.0, and.
3. structures on Site Class D and E sites with S_1 greater than or equal to 0.2.

EXCEPTION: A ground motion hazard analysis is not required for structures other than seismically isolated structures and structures with damping systems where:

1. Structures on Site Class E sites with S_S greater than or equal to 1.0, provided the site coefficient F_a is taken as equal to that of Site Class C.
2. Structures on Site Class D sites with S_1 greater than or equal to 0.2, provided the value of the seismic response coefficient C_s is determined by Eq. (12.8-2) for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Eq. (12.8-3) for $T_L \geq T > 1.5T_s$ or Eq. (12.8-4) for $T > T_L$.
3. Structures on Site Class E sites with S_1 greater than or equal to 0.2, provided that T is less than or equal to T_s and the equivalent static force procedure is used for design.

Input Parameters

Site Characteristics:

$V_{s,30}$ = The weighted-average shear-wave velocity within the upper 30 meters (100 feet)

$Z_{1.0}$ = Depth to shear-wave velocity of 1.0 km/sec

$Z_{2.5}$ = Depth to shear-wave velocity of 2.5 km/sec

From Geophysical Survey: $V_{s,30}$ = 777 ft/sec = 237 m/sec

Site Coordinates: Latitude= 40.9904

Longitude= -111.9005

Estimate Z Values:

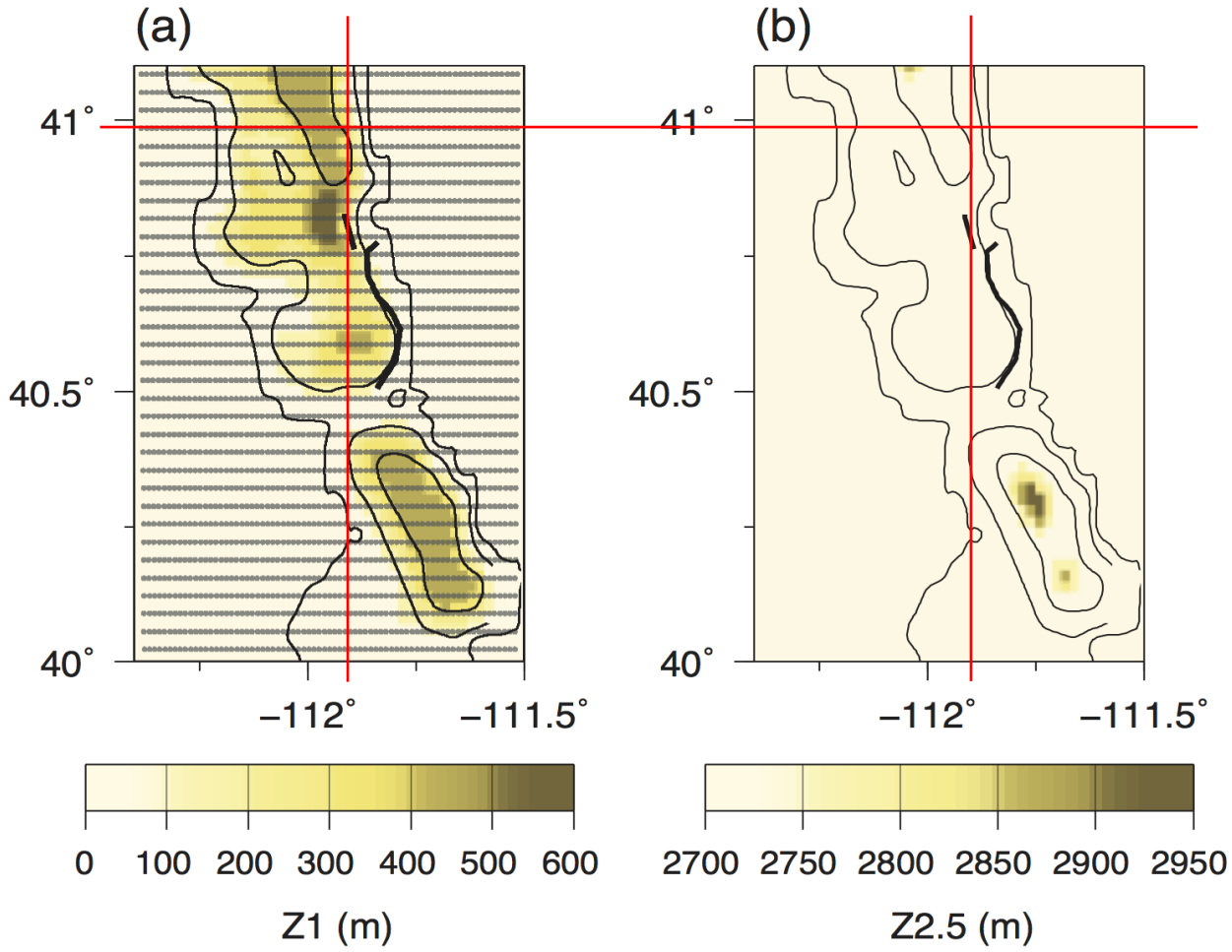
1. Moschetti et al (2017) graphs only go to 41.1°, so not applicable for this site

1. Obtain estimated values from Moschetti et al (2017) graphs (below)

$Z_{1.0}$: **400** meters

$Z_{2.5}$: **2700** meters

(Use 30 for vertical scale & 40 for horizontal scale measurements)



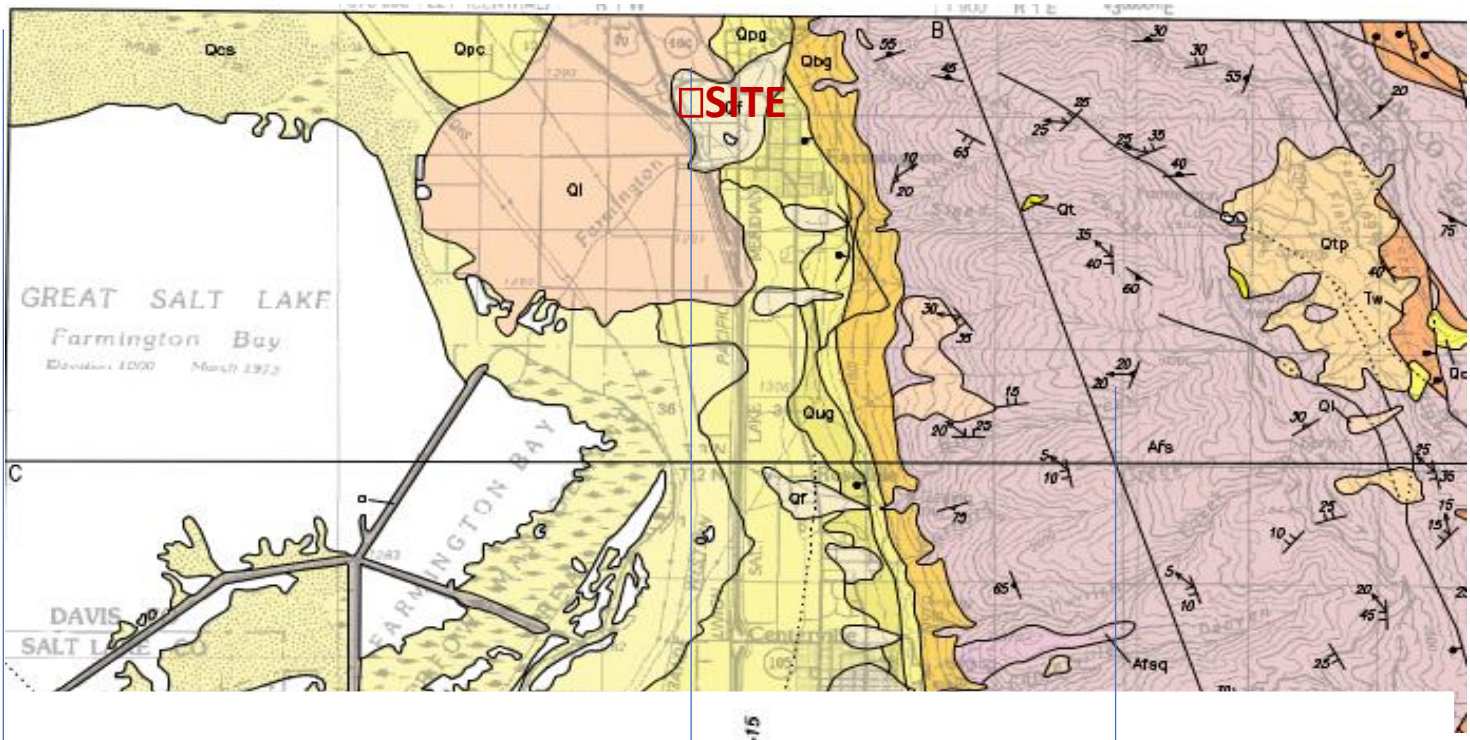
2. Obtain values by interpolating/extrapolating from site geophysical survey:

	depth, ft		Vs, fps			
	121.4		1176			
	150		1227			
extrapolated depth @ 1.0 km/s (3281 fps)=	1301.9	ft	=	396.8	meters	
extrapolated depth @ 2.5 km/s (8202 fps)=	4061.5	ft	=	1237.9	meters	

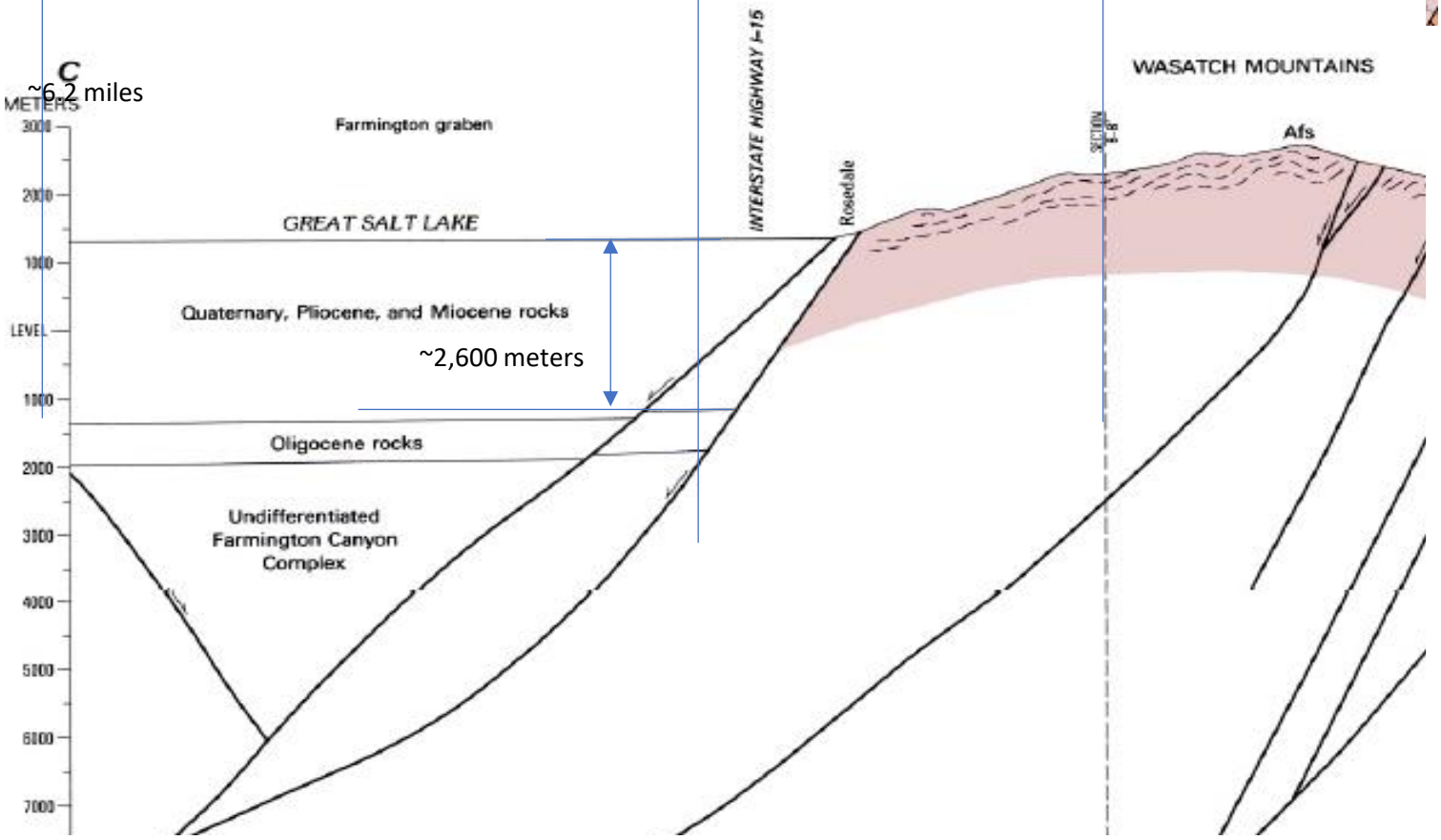
$Z_{1.0}$ = **400** meters

$Z_{2.5}$ = **1240** meters

3. Estimated values from geological cross-section (Bryant, B., 1990, Geologic Map of the Salt Lake City 30' x 60' Quadrangle, North-Central Utah and Uinta County, Wyoming, USGS Map I-1944):



~6.2 miles



Vs = 2500 m/s occurs in hard rock, and we presume this shear wave velocity is reached at the depth to the Oligocene bedrock, at a depth of approximately 2,600 meters,
which is close to the value obtained from the Moschetti graphs above:

$Z_{2.5}$ = **8520** feet
= **2600** meters

4. Average of above values to use for input:

$Z_{1.0}$ = **400** meters

$Z_{2.5}$ = **2650** meters (the extrapolated value of 1240 meters was not used for the average)

= **2.65** km

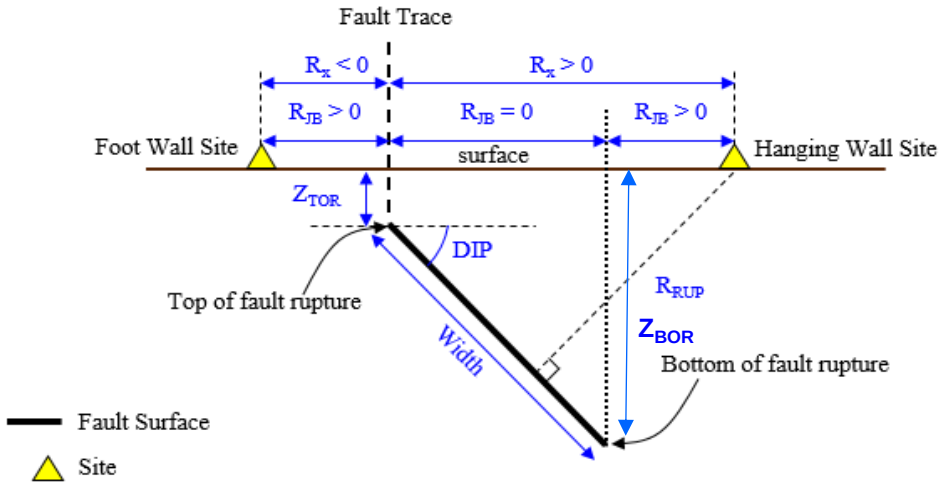
Fault Characteristics and Distances:

For the DSHA, ASCE 7-16 §20.2.2 states, "The largest such acceleration calculated for the characteristic earthquakes on all known active faults active faults within the region shall be used." A single, controlling fault rupture scenario will produce the largest acceleration near the natural period of the building at the site, and will have the most overall influence on the DSHA.

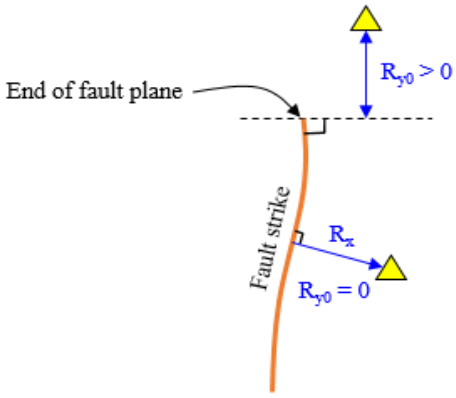
Controlling Fault = Wasatch fault, Weber section [2351e]

Foot or Hanging Wall Site? **Hanging Wall**

See diagram below for values/distances:



Profile View of Normal Fault Geometry



Plan View of Fault Geometry

Fault Sources From EZ-FRISK (200 km radius):

Source	Region	Closest Determin. Fault Distance	Mag./Mech.	Dip Angle/ Dips To	Site Lies	Contribution %
CEUS Gridded Source	USGS 2014 CEUS Gridded Source	0	0.0000 Strike Slip	90.0000 --	Above	0.97
Shallow - Extensional Gridded	USGS 2014 WUS Gridded Source	0	8.0000 N|SS	90.0000 --	Above	10.48
Wasatch fault, Weber section [2351e]	USGS 2014 Utah	0.74	7.1600 Normal	35-65 W	SW	69.49
Salt Lake City - Wasatch Fault Source Model	USGS 2014 Utah	0.78	7.4010 N|SS	35-90 W	Above	17.01
Morgan fault [2353abc]	USGS 2014 Utah	11.67	6.5200 Normal	35-65 W	SW	0.78
West Valley fault [2386]	USGS 2014 Utah	18.84	6.5000 Normal	35-65 E	N	0.16
W65G35 West Valley (Wasatch 65) fault (dip 35	USGS 2014 Utah	19.22	6.5000 Normal	35.0000 E	N	0.03
W50G35 West Valley (Wasatch 50) fault (dip 35	USGS 2014 Utah	19.63	6.5000 Normal	35.0000 E	N	0.08
W35G35 West Valley (Wasatch 35) fault (dip 35	USGS 2014 Utah	20.21	6.5000 Normal	35.0000 E	N	0.02
W65G50 West Valley (Wasatch 65) fault (dip 50	USGS 2014 Utah	20.81	6.5000 Normal	50.0000 E	N	0.07
W50G50 West Valley (Wasatch 50) fault (dip 50	USGS 2014 Utah	20.94	6.5000 Normal	50.0000 E	N	0.17
W35G50 West Valley (Wasatch 35) fault (dip 50	USGS 2014 Utah	21.32	6.5000 Normal	50.0000 E	N	0.05
W50G65 West Valley (Wasatch 50) fault (dip 65	USGS 2014 Utah	22.45	6.5000 Normal	65.0000 E	N	0.04
W65G65 West Valley (Wasatch 65) fault (dip 65	USGS 2014 Utah	22.45	6.5000 Normal	65.0000 E	N	0.02
W35G65 West Valley (Wasatch 35) fault (dip 65	USGS 2014 Utah	22.46	6.5000 Normal	65.0000 E	N	0.01
Great Salt Lake fault zone, Antelope Island [236	USGS 2014 Utah	30.45	6.9300 Normal	35-65 W	NE	0.18
Great Salt Lake fault zone, Fremont Island s [23	USGS 2014 Utah	34.02	6.8300 Normal	35-65 SW	E	0.06
Wasatch fault, Brigham City section [2351d]	USGS 2014 Utah	34.9	6.9500 Normal	35-65 W	SE	0.29

Oquirrh-Southern Oquirrh Mountains fault [239	USGS 2014 Utah	44.31	7.1700 Normal	35-65 W	NE	0.03
East Cache fault zone [2352abc]	USGS 2014 Utah	48.95	7.3100 Normal	35-65 W	S	0.02
Great Salt Lake fault zone, Promontory secti [23	USGS 2014 Utah	51.84	7.0900 Normal	35-65 SW	SE	0.01
Wasatch fault, Provo section [2351g]	USGS 2014 Utah	55.45	7.2700 Normal	35-65 W	N	0.04
West Cache fault, Wellsville section [2521c]	USGS 2014 Utah	65.52	6.6000 Normal	35-65 NE	S	0
Stansbury fault zone [2395]	USGS 2014 Utah	72.1	7.0900 Normal	35-65 W	NE	0
Bear River fault zone [730]	USGS 2014 Wyoming	72.47	6.9000 Normal	35-65	W	0
West Cache fault zone, Junction Hills fault [252	USGS 2014 Utah	78.3	6.7000 Normal	35-65 NE	S	0
Hansel Valley fault [2358]	USGS 2014 Utah	89.85	6.6000 Normal	35-65 E	SE	0
Eastern Bear Lake fault [2364abc]	USGS 2014 Idaho	91.38	7.2900 Normal	35-65 W	S	0
North Promontory fault [2361]	USGS 2014 Nevada	96.7	6.7300 Normal	35-65 W	SE	0
Strawberry fault [2412]	USGS 2014 Utah	97.07	6.9200 Normal	35-65 W	NW	0
Wasatch fault, Nephi section [2351h]	USGS 2014 Utah	100.23	7.0100 Normal	35-65 W	N	0
West Cache fault, Clarkston section [2521a]	USGS 2014 Utah	101.62	6.6600 Normal	35-65 E	S	0
Rock Creek fault [729]	USGS 2014 Wyoming	116.95	6.9500 Normal	35-65 W	SW	0
Wasatch fault, Levan section [2351i]	USGS 2014 Utah	149.83	6.8300 Normal	35-65 W	N	0
Joes Valley fault zone [2455]	USGS 2014 Utah	160.39	7.0200 Normal	35-65 W	N	0
Grand Valley fault [726c]	USGS 2014 Wyoming	182.6	7.1000 Normal	35-65 W	S	0

Fault Sources From 2014 National Seismic Hazard Maps (200 km search radius):

Distance (km)	Name	State	Geologic Slip Rate (mm/year)	Dip (degrees)	Dip Dir	Slip Sense	Rupture Top (km)	Rupture Bottom (km	Length (km)
1.3	Wasatch fault, Weber section	UT	2.48	50/65/35	W	normal	0	15	63
15.7	Wasatch fault, Salt Lake City se	UT	1.7	50/65/35	W	normal	0	15	52
19.9	Morgan fault	UT	0.03	50/65/35	W	normal	0	15	17
23.6	West Valley fault	UT	0.52	50/65/35	E	normal	0	15	17
30.5	Great Salt Lake fault zone, Ante	UT	0	50/65/35	W	normal	0	15	39
34.1	Great Salt Lake fault zone, Fren	UT	0	50/65/35	W	normal	0	15	32
38.4	Wasatch fault, Brigham City sec	UT	2.09	50/65/35	W	normal	0	15	41
44.4	Oquirrh-Southern Oquirrh Mou	UT	0.26	50/65/35	W	normal	0	15	63
49.1	East Cache fault zone	UT	0.26	50/65/35	W	normal	0	15	83
52.0	Great Salt Lake fault zone, Pron	UT	0	50/65/35	W	normal	0	15	54
55.4	Wasatch fault, Provo section	UT	2.61	50/65/35	W	normal	0	15	77
65.5	West Cache fault, Wellsville sec	UT	0.13	50/65/35	NE	normal	0	15	20
72.3	Stansbury fault zone	UT	0.52	50/65/35	W	normal	0	15	54
78.3	West Cache fault zone, Junctior	UT	0.26	50/65/35	NE	normal	0	15	25
92.6	Bear River fault zone	WY	1.96	50/65/35	W	normal	0	15	37
96.8	North Promontory fault	UT	0.26	50/65/35	W	normal	0	15	27
97.1	Strawberry fault	UT	0.13	50/65/35	W	normal	0	15	39
101.6	West Cache fault, Clarkston sec	UT	0.52	50/65/35	E	normal	0	15	23
101.6	Wasatch fault, Nephi section	UT	2.22	50/65/35	W	normal	0	15	46
102.4	Eastern Bear Lake fault	ID	0.78	50/65/35	W	normal	0	15	81
105.2	Hansel Valley fault	UT	0.16	50/65/35	E	normal	0	15	13
125.3	Rock Creek fault	WY	0.81	50/65/35	W	normal	0	15	41
149.7	Wasatch fault, Levan section	UT	0.39	50/65/35	W	normal	0	15	32
164.8	Joes Valley fault zone	UT	0.26	50/65/35	W	normal	0	15	47

Fault Source Distances:

1.01 = R_x = Horizontal distance from top of rupture measured perpendicular to fault strike (km) (see map below)

0 = R_{y0} = The horizontal distance off the end of the rupture measured parallel to strike (km)



Fault Magnitude

EZFRISK considers three fault rupture scenarios for the Wasatch fault: full segment rupture, partial segment rupture, and rupture of the entire length of the fault. For our GMHA, all three fault rupture scenarios for the Wasatch fault source are used for estimating the probabilistic ground motion at the site. However, for deterministic ground motions, the largest characteristic magnitude is Mw=7.4 for rupture of the entire ±357 km length of the Wasatch fault (all segments rupture simultaneously). The paleoseismic data suggests these various segments of the Wasatch fault have ruptured somewhat independently (https://earthquake.usgs.gov/cfusion/qfault/show_report_AB_archive.cfm?fault_id=2351&section_id=f). Accordingly, it is our opinion this highly unlikely fault rupture scenario should not be included for estimation of deterministic ground motions, but should instead be divided into individual fault segments.

Summary of Fault Characteristics and Distances:

7.15 = M_w = Moment magnitude (enter for individual fault segment)

0.74 = R_{RUP} = Closest distance to coseismic rupture (km)

0 = R_{JB} = Closest distance to surface projection of coseismic rupture (km)

1.01 = R_x = Horizontal distance from top of rupture measured perpendicular to fault strike (km)

0 = R_{y0} = The horizontal distance off the end of the rupture measured parallel to strike (km)

237 = $V_{S,30}$ = Shear wave velocity in upper 30 meters (m/s)

1 = Hanging Wall Site (Fhw)

50 = Dip = Average dip of rupture plane (degrees)

0 = Z_{TOR} = Depth to top of coseismic rupture (km) (Usually 0)

15 = Z_{BOR} = Depth to bottom of coseismic rupture (km)

0.4 = $Z_{1.0}$ = Depth to shear wave velocity of 1.0 km/sec (km)

2.65 = $Z_{2.5}$ = Depth to shear wave velocity of 2.5 km/sec (km)

19.58 = W = Fault rupture width (km) = $(Z_{TOB} - Z_{TOR})/\sin(Dip)$

Analysis

21.2 RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION HAZARD ANALYSIS

The requirements of Section 21.2 shall be satisfied where a ground motion hazard analysis is performed or required by Section 11.4.7. The ground motion hazard analysis shall account for the regional tectonic setting, geology, and seismicity; the expected recurrence rates and maximum magnitudes of earthquakes on known faults and source zones; the characteristics of ground motion attenuation near source effects, if any, on ground motions; and the effects of subsurface site conditions on ground motions. The characteristics of subsurface site conditions shall be considered either using attenuation relations that represent regional and local geology or in accordance with Section 21.1. The analysis shall incorporate current seismic interpretations, including uncertainties for models and parameter values for seismic sources and ground motions. If the spectral response accelerations predicted by the attenuation relations do not represent the maximum response in the horizontal plane, then the response spectral accelerations computed from the hazard analysis shall be scaled by factors to increase the motions to the maximum response. If the attenuation relations predict the geometric mean or similar metric of the two horizontal components, then the scale factors shall be 1.1 for periods less than or equal to 0.2 s, 1.3 for a period of 1.0 s, and 1.5 for periods greater than or equal to 5.0 s, unless it can be shown that other scale factors more closely represent the maximum response, in the horizontal plane, to the geometric mean of the horizontal components. Scale factors between these periods shall be obtained by linear interpolation. The analysis shall be documented in a report.

Probabilistic Spectra

21.2.1 Probabilistic (MCE_R) Ground Motions. The probabilistic spectral response accelerations shall be taken as the spectral response accelerations in the direction of maximum horizontal response represented by a 5% damped acceleration response spectrum that is expected to achieve a 1% probability of collapse within a 50-year period. For the purpose of this standard, ordinates of the probabilistic ground motion response spectrum shall be determined by either Method 1 of Section 21.2.1.1 or Method 2 of Section 21.2.1.2.

21.2.1.1 Method 1. At each spectral response period for which the acceleration is computed, ordinates of the probabilistic ground motion response spectrum shall be determined as the product of the risk coefficient, C_R, and the spectral response acceleration from a 5% damped acceleration response spectrum that has a 2% probability of exceedance within a 50-year period. The value of the risk coefficient, C_R, shall be determined using values of C_{RS} and C_{R1} from Figs. 22-18 and 22-19, respectively. At spectral response periods less than or equal to 0.2 s, C_R shall be taken as equal to C_{RS}. At spectral response periods greater than or equal to 1.0 s, C_R shall be taken as equal to C_{R1}. At response spectral periods greater than 0.2 s and less than 1.0 s, C_R shall be based on linear interpolation of C_{RS} and C_{R1}.

EZ-FRISK Software

The *EZ-FRISK* software fulfills the requirements outlined in ASCE 7-16 Section 21.2 regarding ground motion hazard analyses (GMHA). The input values given above and the USGS 2014 (Peterson et al) seismic source database were used in *EZ-FRISK* for the GMHA. The resulting values are the mean spectral accelerations in the horizontal plane (RotD50), which must be corrected for maximum spectral accelerations in the horizontal plane (fault normal, or RotD100) conditions. As indicated in Section 21.2, other appropriat scaling factors than those provided can be used. Accordingly, we used the scaling factors provided by Shahi and Baker (2014

As indicated above, since *EZ-FRISK* include simultaneous rupture of all segments for the entire Wasatch fault, we also utilized the NGA West2 worksheet/spreadsheet provided by PEER to obtain spectral values for the DSHA analysis using the following single segment of the Wasatch fault:

Weber Segment of Wasatch Fault

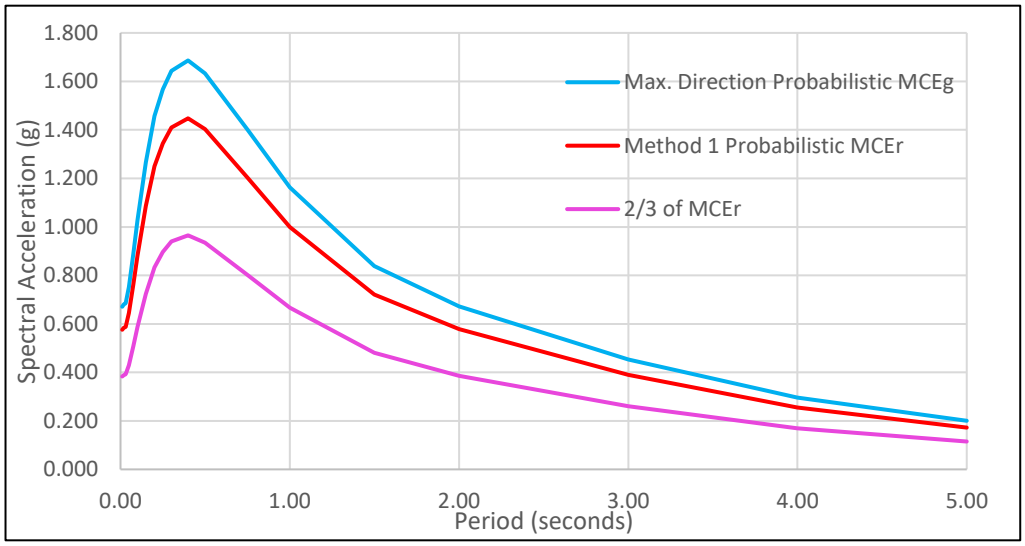
Probabilistic Spectra Results from *EZ-FRISK*:

Probabilistic Spectra results for EZ-FRISK 8.07 Build 044
0
ANNUAL FREQUENCY OF EXCEEDANCE: 4.041e-004
ROTD50 MEAN VALUES AS SHOWN BELOW

From OSHPD Web Tool (attached):

C_{RS} = 0.858
C_{R1} = 0.860

Period (s)	RotD50 MCE_G S_a (g)	Shahi and Baker (2014) Dir. Factors	Max. Direct. Probablstc MCE_G S_a (g)	Risk Coefficients C_R	Method 1 Probablstc MCE_R S_a (g)	2/3 of MCE_R S_a (g)
0.01	0.563	1.190	0.670	0.8580	0.575	0.383
0.02	0.571	1.190	0.680	0.8580	0.583	0.389
0.03	0.576	1.190	0.685	0.8580	0.588	0.392
0.05	0.632	1.190	0.751	0.8580	0.645	0.430
0.075	0.748	1.190	0.890	0.8580	0.764	0.509
0.10	0.864	1.190	1.028	0.8580	0.882	0.588
0.15	1.055	1.200	1.266	0.8580	1.086	0.724
0.20	1.204	1.210	1.457	0.8580	1.250	0.833
0.25	1.284	1.220	1.566	0.8581	1.344	0.896
0.30	1.347	1.220	1.643	0.8583	1.410	0.940
0.40	1.371	1.230	1.686	0.8585	1.448	0.965
0.50	1.328	1.230	1.633	0.8588	1.403	0.935
0.75	1.129	1.240	1.400	0.8594	1.203	0.802
1.00	0.938	1.240	1.163	0.8600	1.000	0.667
1.50	0.676	1.240	0.838	0.8600	0.721	0.481
2.00	0.542	1.240	0.672	0.8600	0.578	0.385
3.00	0.363	1.250	0.454	0.8600	0.390	0.260
4.00	0.235	1.260	0.296	0.8600	0.255	0.170
5.00	0.159	1.260	0.200	0.8600	0.172	0.115



Deterministic Spectra (NGA West2 Spreadsheet)

The NGA West2 Spreadsheet is used as part of the deterministic hazard seismic analysis, using 5% damping and the input parameters listed above, for the Weber Segment of Wasatch Fault (see results below).

PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER

WEIGHTED AVERAGE of 2014 NGA WEST-2 GMPEs

Last updated: 04 14 15

by Emel Seyhan, PhD, PEER & UCLA -- email: emel.seyhan@gmail.com, peer_center@berkeley.edu

This excel file will be updated as necessary on the PEER website to fix any typos or other errors. Please check the website frequently for new versions at: http://peer.berkeley.edu/ngawest2/databases/

Legend	Pre-defined option	Main input variable	Calculated variable	Input var. flag	Internal variable

GMPE averaging	Geometric	*Weighted average of the natural logarithm of the spectral values*

GMPEs	***ASK14***	***BSSA14***	***CB14***	***CY14***	***I14***
Weight	0.25	0.25	0.25	0.25	0

# of std. dev.	1
Damping ratio (%)	5

Modification factors are calculated in Sheet DSF

ASK14	Abrahamson & Silva & Kamai 2014 NGA West-2 Model
BSSA14	Boore & Stewart & Seyhan & Atkinson 2014 NGA West-2 Model
CB14	Campbell & Bozorgnia 2014 NGA West-2 Model
CY14	Chiou & Youngs 2014 NGA West-2 Model
I14	Idriss 2014 NGA West-2 Model

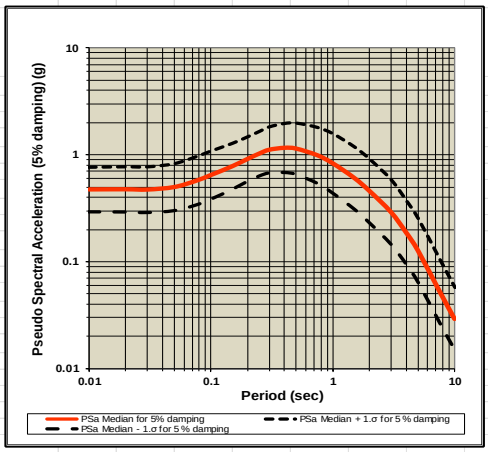
RotD50 Horizontal Component of PGA, PGV and *IMs*

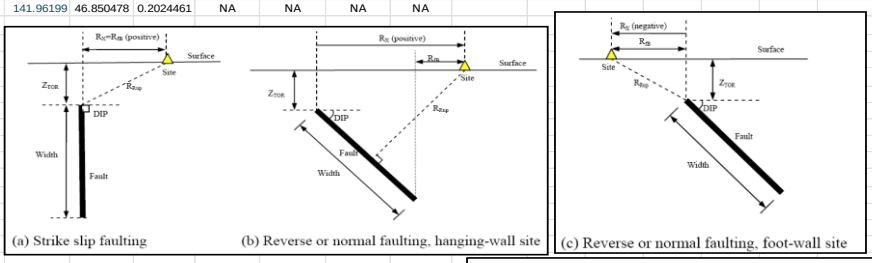
Input variables	Errors and warnings
M_w	
7.15	
R_{RUP} (km)	
0.74	
R_{JB} (km)	
0	
R_X (km)	
1.01	
Ry0 (km)	*If unknown use 999*
0	
V_{S30} (m/sec)	
237	
U (BSSA13)	*1: Unspecified fault mech.*
0	
F_{RV}	*1: reverse fault*
0	
F_{NM}	*1: normal fault*
1	
F_{HW}	*1: hanging wall side*
1	
Dip (deg)	
50	
Z_{TOR} (km)	*If unknown use 999*
0	
Z_{HYP} (km)	*If unknown use 999*
999	
$Z_{1.0}$ (km)	*If unknown use 999*
0.4	
$Z_{2.5}$ (km)	*If unknown use 999*
2.65	
W (km)	*If unknown use 999*
19.58	
Vs30Flag	
measured	*Choose options for V_{s30} from the list*
F_{AS}	
no	*Aftershock effect is not applicable.*
Region	
Global	*Choose region from the list*

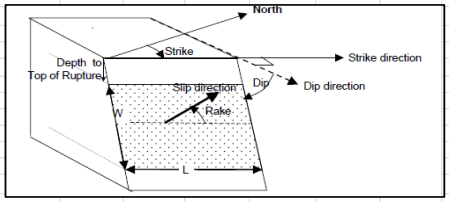
Calculated Variables/Flags

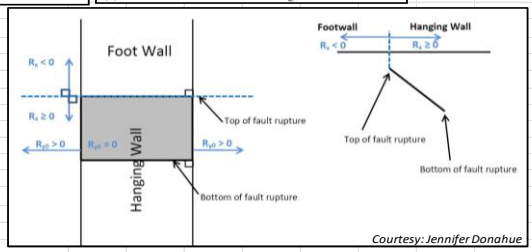
ΔDPP	*Always 0 for median calcs.*
0	
PGA_r (g)	
0.369	
Z_{BOT} (km) (CB14)	*Enter for default W calcs*
15	
SS	
0	*auto calculated*
$V_{s30Flag}$	
1	*measured*
F_{AS}	
0	*Aftershock effect is not applicable.*
Region	
0	*Global*
Option for Sa value	
1	*Weighted average of the natural logarithm of the spectral values*

GMP	T (s)	Baseline: 5% Damping: PSa Median for 5% damping	PSa Median + 1.σ for 5% damping	PSa Median - 1.σ for 5% damping	S_d Median for 5% damping	User defined: 5% Damping: PSa Median for 5% damping	PSa Median + 1.σ for 5 % damping	PSa Median - 1.σ for 5 % damping	Sd Median for 5 % damping
PSa (g), S_d (cm)	0.01	0.4753707	0.7679563	0.2942581	0.00118	0.4753707	0.7679563	0.2942581	0.00118
	0.02	0.4768693	0.7755649	0.2932112	0.0047351	0.4768693	0.7755649	0.2932112	0.0047351
	0.03	0.4742341	0.7748305	0.2902544	0.010595	0.4737599	0.7740557	0.2899642	0.0105844
	0.05	0.5008655	0.8298939	0.3022871	0.0310833	0.5003646	0.829064	0.3019849	0.0310522
	0.075	0.5699662	0.9574699	0.3392916	0.0795862	0.5711061	0.9593848	0.3399702	0.0797454
	0.1	0.6467829	1.084479	0.385741	0.1605554	0.6480764	1.086648	0.3865125	0.1608765
	0.15	0.7816916	1.2807607	0.4770928	0.4366006	0.783255	1.2833222	0.478047	0.4374738
	0.2	0.9150119	1.4752802	0.5675171	0.9085589	0.9159269	1.4767555	0.5680847	0.9094675
	0.25	1.0224494	1.649879	0.633624	1.5863105	1.0285841	1.6597783	0.6374257	1.5958283
	0.3	1.1140197	1.8270331	0.6792651	2.4888671	1.1140197	1.8270331	0.6792651	2.4888671
	0.4	1.1610626	1.9669863	0.6853461	4.6114974	1.1622237	1.9689533	0.6860315	4.6161088
	0.5	1.1419996	1.9849651	0.6570207	7.0871612	1.1431416	1.9869501	0.6576777	7.0942484
	0.75	0.989945	1.8085031	0.5418797	13.822924	0.9889551	1.8066946	0.5413378	13.809101
	1	0.8346303	1.5844452	0.439654	20.718604	0.832961	1.5812763	0.4387747	20.677167
	1.5	0.6087273	1.1910818	0.3111029	33.999432	0.6087273	1.1910818	0.3111029	33.999432
	2	0.4615592	0.9181111	0.2320382	45.830406	0.4601745	0.9153568	0.2313421	45.692915
	3	0.2933454	0.5886618	0.1461816	65.537247	0.2927588	0.5874845	0.1458893	65.406173
	4	0.1885878	0.3748404	0.0948813	74.903116	0.1885878	0.3748404	0.0948813	74.903116
	5	0.1285715	0.256092	0.0645496	79.790485	0.1280572	0.2550677	0.0642914	79.471323
	7.5	0.0535874	0.1064464	0.026977	74.825784	0.053641	0.1065529	0.027004	74.90061
	10	0.0294746	0.0580003	0.0149784	73.166875	0.0293862	0.0578263	0.0149335	72.947375
PGA (g)	0	0.4725272	0.7628596	0.2926908	0.001173	0.4753707	0.7679563	0.2942581	0.00118
PGV (cm/s)	-1	81.553584	141.96199	46.850478	0.2024461	NA	NA	NA	NA









Definition of Parameters

Damping ratio	= Viscous damping ratio (%) See Sanaz et al. (2012) PEER Report
PSA	= Pseudo-absolute acceleration response spectrum (g)
PGA	= Peak ground acceleration (g)
PGV	= Peak ground velocity (cm/s)
S_d	= Relative displacement response spectrum (cm)
M_w	= Moment magnitude
R_{RUP}	= Closest distance to coseismic rupture (km), used in ASK13, CB13 and CY13. See Figures a, b and c for illustation
R_{JB}	= Closest distance to surface projection of coseismic rupture (km). See Figures a, b and c for illustation
R_X	= Horizontal distance from top of rupture measured perpendicular to fault strike (km). See Figures a, b and c for illustation
R_{y0}	= The horizontal distance off the end of the rupture measured parallel to strike (km)
V_{S30}	= The average shear-wave velocity (m/s) over a subsurface depth of 30 m
U	= Unspecified-mechanism factor: 1 for unspecified; 0 otherwise
F_{RV}	= Reverse-faulting factor: 0 for strike slip, normal, normal-oblique; 1 for reverse, reverse-oblique and thrust
F_{NM}	= Normal-faulting factor: 0 for strike slip, reverse, reverse-oblique, thrust and normal-oblique; 1 for normal
F_{HW}	= Hanging-wall factor: 1 for site on down-dip side of top of rupture; 0 otherwise
Dip	= Average dip of rupture plane (degrees)
Z_{TOR}	= Depth to top of coseismic rupture (km)
Z_{HYP}	= Hypocentral depth from the earthquake
$Z_{1.0}$	= Depth to Vs=1 km/sec
$Z_{2.5}$	= Depth to Vs=2.5 km/sec
W	= Fault rupture width (km)
$V_{s30flag}$	= 1 for measured, 0 for inferred Vs30
F_{AS}	= 0 for mainshock; 1 for aftershock
Region	= Specific regions considered in the models, Click on Region to see codes
ΔDPP	= Directivity term, direct point parameter; uses 0 for median predictions
PGA_r (g)	= Peak ground acceleration on rock (g), this specific cell is updated in the cell for BSSA14 and CB14, for others it is taken account for in the macros
Z_{BOT} (km)	= The depth to the bottom of the seismogenic crust
Z_{BOR}(km)	= The depth to the bottom of the rupture plane
SS	= 1 for strike slip, automatically updated in the cell

Input variables with defaults (If entered 999 as input):

Red colored value: The value is used in the code when input is unknown

DEFAULTs	USER defined	ASK14	BSSA14	CB14	CY14	I14
W (km)	19.58			19.531		
$Z_{1.0}$ (km)	0.400	0.400			0.496	
$\delta Z_{1.0}$ (km)	-0.097		-0.097			
$Z_{2.5}$ (V_{S30}=1100)(km)	2.650			0.398		
$Z_{2.5}$ (V_{S30})(km)	2.650			2.301		
Z_{hyp} (km)	999.00			10.265		
Z_{tor} (km)	0.00			0.039	0.039	
Z_{BOR} (km)	-			15.000		

ACKNOWLEDGEMENTS

Nick Gregor, Bechtel
Silvia Mazzoni, Consultant
Sanaz Rezaeian, USGS

All NGA West-2 participants are acknowledged for their constructive comments and feedback.

Scale Deterministic Spectra to Obtain Maximum Acceleration in the Horizontal Plane

The results from the NGA-West2 spreadsheet shown above are calculated as the mean spectral accelerations in the horizontal plane (RotD50). ASCE 7-16 Section 21.2 (see above) requires that maximum accelerations in the horizontal plane (RotD100) be used for the spectral response. Section 21.2 also provides default directivity scaling factors, but allows the use of other appropriate scaling factors. For our analysis, we used the scaling factors presented by Shahi and Baker (2014). Following are the results from the spreadsheet for 5% damping, the directivity scaling factors and the resulting 84th percentile maximum direction (RotD100) values.

		Baseline: 5% Damping					
GMP	T (s)	PSa Median for 5% damping	PSa Median + 1.σ for 5% damping*	PSa Median - 1.σ for 5% damping	S_d Median for 5% damping	Shahi & Baker(2014) Dir.Factors	84th %tile Maximum Direction Sa
	0.01	0.47537075	0.76795629	0.29425808	0.00118005	1.19	0.914
	0.02	0.4768693	0.77556485	0.29321123	0.00473506	1.19	0.923
	0.03	0.47423409	0.7748305	0.29025442	0.01059502	1.19	0.922
	0.05	0.5008655	0.82989387	0.30228715	0.03108332	1.19	0.988
	0.075	0.5699662	0.95746985	0.33929159	0.07958624	1.19	1.139
	0.1	0.64678287	1.08447905	0.38574105	0.16055537	1.19	1.291
	0.15	0.78169159	1.28076067	0.47709284	0.43660057	1.2	1.537
	0.2	0.91501193	1.47528024	0.56751715	0.9085589	1.21	1.785
	0.25	1.02244943	1.64987899	0.63362395	1.58631048	1.22	2.013
PSa (g), S_d (cm)	**0.3**	1.11401968	1.82703313	0.6792651	2.48886712	1.22	2.229
	0.4	1.16106262	1.96698628	0.68534611	4.61149735	1.23	2.419
	0.5	1.14199963	1.98496513	0.65702069	7.08716122	1.23	2.442
	0.75	0.989945	1.80850306	0.5418797	13.8229244	1.24	2.243
	1	0.8346303	1.58444522	0.43965404	20.7186038	1.24	1.965
	1.5	0.60872734	1.19108179	0.31110288	33.9994324	1.24	1.477
	2	0.46155916	0.9181111	0.23203822	45.8304065	1.24	1.138
	3	0.29334544	0.58866184	0.14618163	65.5372472	1.25	0.736
	4	0.18858779	0.37484043	0.09488132	74.9031158	1.26	0.472
	5	0.12857151	0.25609202	0.06454959	79.7904848	1.26	0.323
	7.5	0.05358737	0.10644641	0.02697701	74.8257842	1.28	0.136
	10	0.02947462	0.05800029	0.01497843	73.1668751	1.29	0.075

*84th percentile

If the maximum deterministic acceleration is less than $1.5F_a$, Section 21.2.2 in ASCE 7-16 Supplement 1 requires that the deterministic spectra be scaled "up" so that the maximum acceleration = $1.5F_a$.

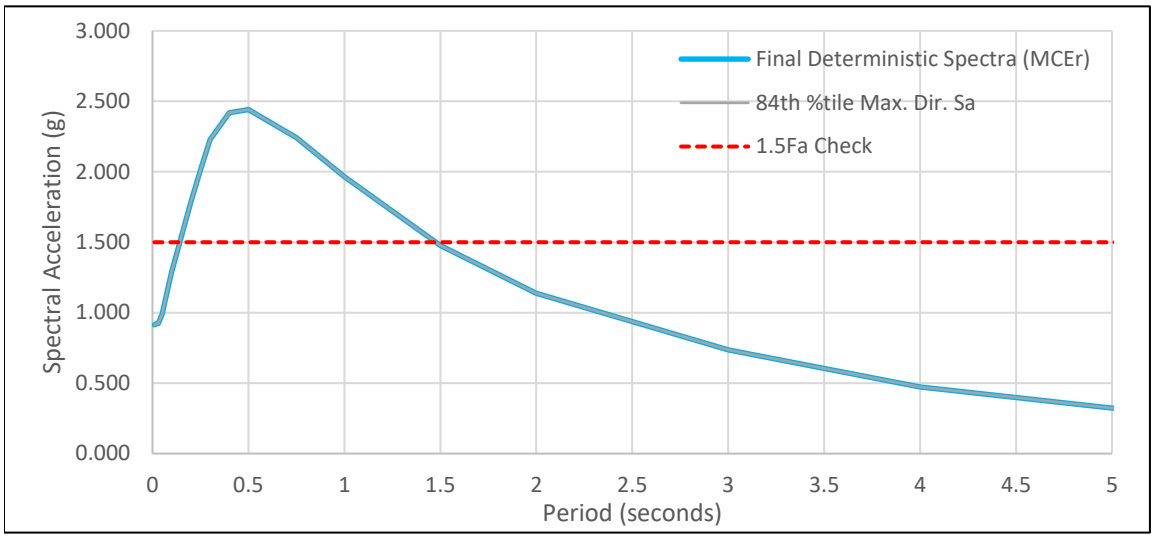
21.2.2 Deterministic (MCE_R) Ground Motions.

The deterministic spectral response acceleration at each period shall be calculated as an 84th-percentile 5% damped spectral response acceleration in the direction of maximum horizontal response computed at that period. The largest such acceleration calculated for the characteristic earthquakes on all known active faults within the region shall be used. If the largest spectral response acceleration of the resulting deterministic ground motion response spectrum is less than $1.5F_a$, then this response spectrum shall be scaled by a single factor such that the maximum response spectral acceleration equals $1.5F_a$. For Site Classes A, B, C and D, Fa shall be determined using Table 11.4.1, with the value of S_s taken as 1.5; for Site Class E, F_a shall be taken as 1.0. ~~The ordinates of the deterministic ground motion response spectrum shall not be taken as lower than the corresponding ordinates of the response spectrum determined in accordance with Fig. 21.2-1. For the purposes of calculating the ordinates.~~

Site Class =	D	(see above)
F_a =	1.000	(From ASCE 7-16 Table 11.4.1)
$1.5F_a$ =	1.500	
Max S_a (g) =	2.442	(84th %tile Maximum Direction Sa)
Scale Factor =	1.000	($1.5F_a$ / Max S_a [if<$1.5F_a$])

Note: The Scaled 84th percentile maximum direction S_a values are also the Final Deterministic Spectra (MCE_R) (see graph below).

T (s)	Maximum Direction	Scaled 84th %tile Max Direction S_a
0.01	0.914	0.914
0.02	0.923	0.923
0.03	0.922	0.922
0.05	0.988	0.988
0.075	1.139	1.139
0.1	1.291	1.291
0.15	1.537	1.537
0.2	1.785	1.785
0.25	2.013	2.013
0.3	2.229	2.229
0.4	2.419	2.419
0.5	2.442	2.442
0.75	2.243	2.243
1	1.965	1.965
1.5	1.477	1.477
2	1.138	1.138
3	0.736	0.736
4	0.472	0.472
5	0.323	0.323
7.5	0.136	0.136
10	0.075	0.075



21.3 DESIGN RESPONSE SPECTRUM

The design spectral response acceleration at any period shall be determined from Eq. (21.3-1):

$$S_a = \frac{2}{3} S_{aM} \qquad (21.3\text{-}1)$$

where S_{aM} is the MCE spectral response acceleration obtained from Section 21.1 or 21.2.

The design spectral response acceleration at any period shall not be taken as less than 80% of S_a determined in accordance with Section 11.4.6, where F_a and F_v are determined as follows:

(i) for Site Class A, B, and C: F_a and F_v are determined using Tables 11.4-1 and 11.4-2, respectively;
(ii) for Site Class D: F_a is determined using Table 11.4-1, and F_v is taken as 2.4 for $S_1 < 0.2$ or 2.5 for $S_1 \geq 0.2$; and
(iii) for Site Class E: F_a is determined using Table 11.4-1 for $S_S < 1.0$ or taken as 1.0 for $S_S \geq 1.0$, and F_v is taken as 4.2 for $S_1 \leq 0.1$ or 4.0 for $S_1 > 0.1$.

For sites classified as Site Class F requiring site-specific analysis in accordance with Section 11.4.7, the design spectral response acceleration at any period shall not be less than 80% of S_a determined for Site Class E in accordance with Section 11.4.5.

11.4.6 Design Response Spectrum. Where a design response spectrum is required by this standard and site-specific ground motion procedures are not used, the design response spectrum curve shall be developed as indicated in Fig. 11.4-1 and as follows:

1. For periods less than T_0, the design spectral response acceleration, S_a, shall be taken as given in Eq. (11.4-5):

$$S_a = S_{DS}\left(0.4 + 0.6\frac{T}{T_0}\right) \qquad (11.4\text{-}5)$$

2. For periods greater than or equal to T_0 and less than or equal to T_S, the design spectral response acceleration, S_a, shall be taken as equal to S_{DS}.
3. For periods greater than T_S and less than or equal to T_L, the design spectral response acceleration, S_a, shall be taken as given in Eq. (11.4-6):

$$S_a = \frac{S_{D1}}{T} \qquad (11.4\text{-}6)$$

4. For periods greater than T_L, S_a shall be taken as given in Eq. (11.4-7):

$$S_{D1} T_L$$

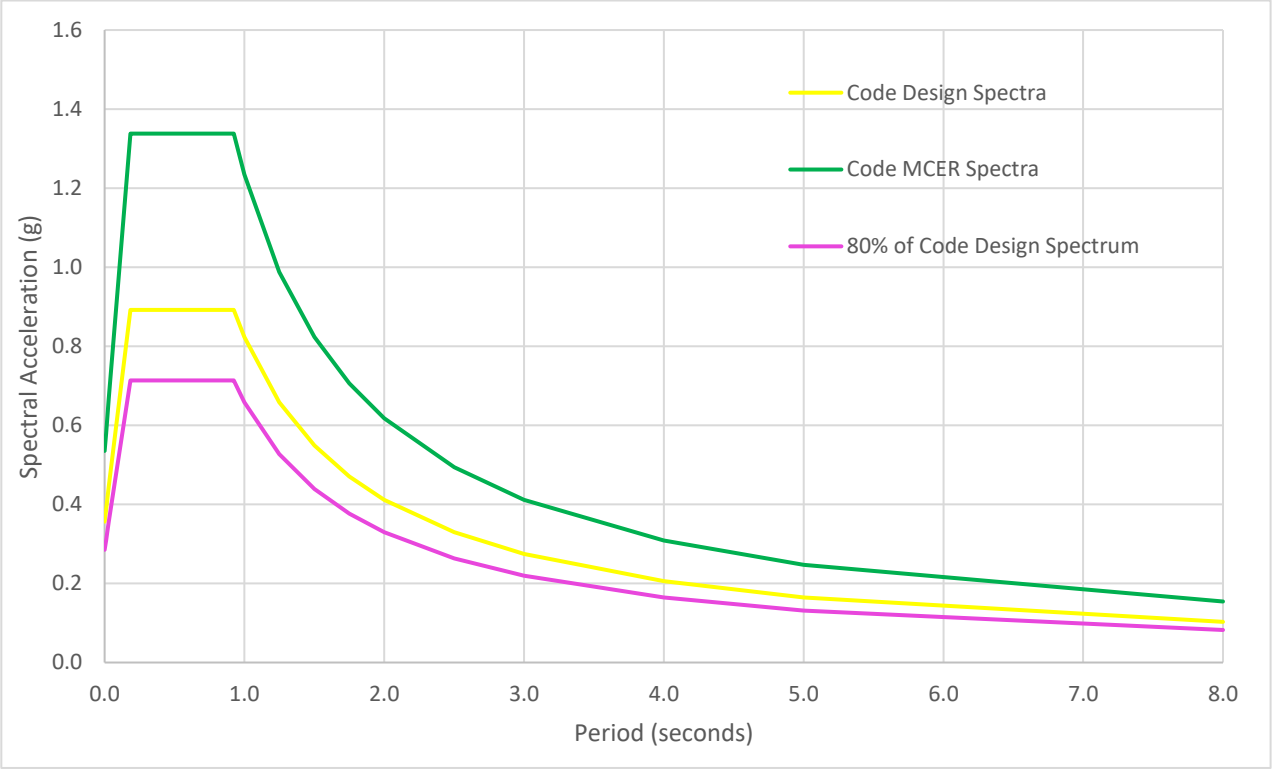
S_S =	1.338	(see above)
S_1 =	0.494	(see above)
F_a =	1.000	(see Section 21.3)
F_v =	2.500	(see Section 21.3)
S_{MS} =	1.338	(=S_S * F_a)
S_{M1} =	1.235	(=S_1 * F_v)
S_{DS} =	0.892	(=2/3 * S_{MS})
S_{D1} =	0.823	(=2/3 * S_{M1})
T_o =	0.185	(=0.2S_{D1}/S_{DS})
T_S =	0.923	(=S_{D1}/S_{DS})
T_L =	8	(from ASCE 7-16 Fig. 22-14)

	Period (s)	Code Design Spectra	Code MCE_R Spectra	80% of Code Des. Spectra
(PGA)	0.00	0.357	0.535	0.285
	0.01	0.386	0.579	0.309
	0.02	0.415	0.622	0.332
	0.03	0.444	0.666	0.355
(T_o)	0.185	0.892	1.338	0.714
(T_s)	0.923	0.892	1.338	0.714
	1.00	0.823	1.235	0.659
	1.00	0.823	1.235	0.659
	1.25	0.659	0.988	0.527
	1.50	0.549	0.823	0.439
	1.75	0.470	0.706	0.376
	2.00	0.412	0.618	0.329
	2.50	0.329	0.494	0.263
	3.00	0.274	0.412	0.220
	4.00	0.206	0.309	0.165
	5.00	0.165	0.247	0.132
(T_L)	8.00	0.103	0.154	0.082

$$S_a = \frac{S_{D1} T_L}{T^2} \qquad (11.4\text{-}7)$$

where

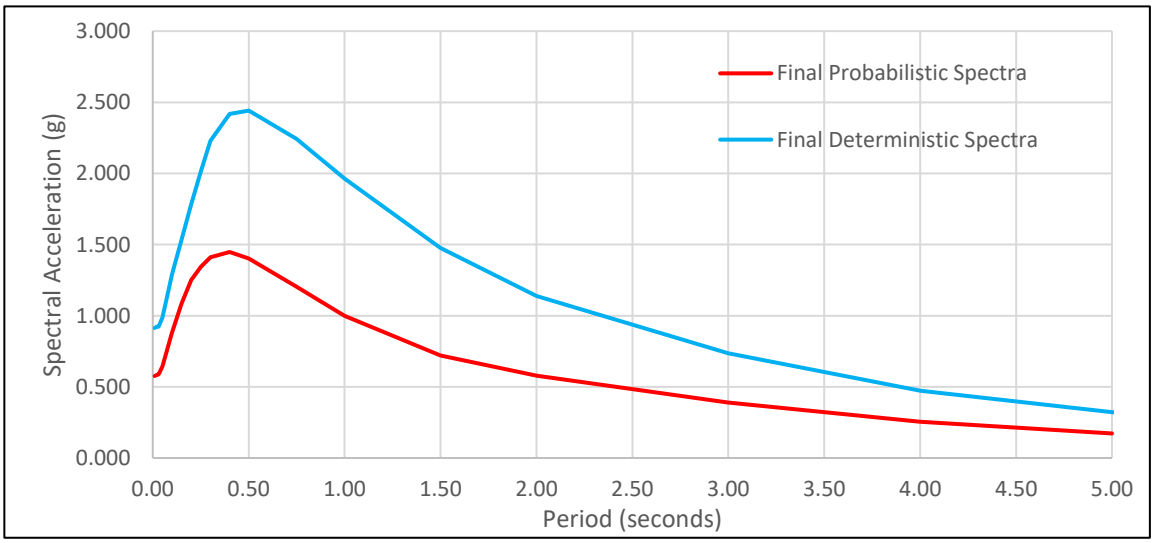
S_{DS} = the design spectral response acceleration parameter at short periods
S_{D1} = the design spectral response acceleration parameter at a 1-s period
T = the fundamental period of the structure, s
$T_0 = 0.2(S_{D1}/S_{DS})$
$T_S = S_{D1}/S_{DS}$, and
T_L = long-period transition period(s) shown in Figs. 22-14 through 22-17.

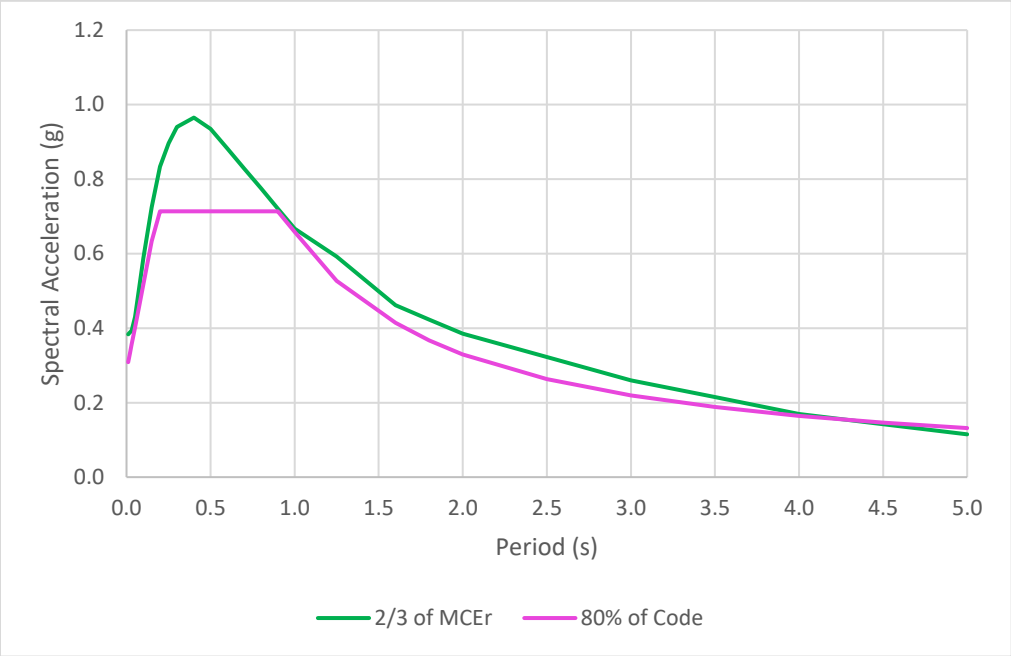


Calculate Final MCE $_R$ and Design Response Spectra

21.2.3 Site-Specific MCE$_R$. The site-specific MCE$_R$ spectral response acceleration at any period, S_{aM}, shall be taken as the lesser of the spectral response accelerations from the probabilistic ground motions of Section 21.2.1 and the deterministic ground motions of Section 21.2.2.

The Probabilistic spectra is the lesser of the two, and thus is used as the site-specific spectra for developing the final design spectra.





Period (s)	2/3 of MCE_R S_a (g)	80% of Code Des. Spectra	Design Spectra S_a (g)
0.01	0.383	0.309	0.383
0.02	0.389	0.332	0.389
0.03	0.392	0.355	0.392
0.05	0.430	0.401	0.430
0.075	0.509	0.459	0.509
0.10	0.588	0.517	0.588
0.15	0.724	0.633	0.724
0.20	0.833	0.714	0.833
0.25	0.896	0.714	0.896
0.30	0.940	0.714	0.940
0.40	0.965	0.714	0.965
0.50	0.935	0.714	0.935
0.60	0.882	0.714	0.882
0.70	0.829	0.714	0.829
0.80	0.775	0.714	0.775
0.90	0.721	0.714	0.721
1.00	0.667	0.659	0.667
1.25	0.592	0.527	0.592
1.25	0.592	0.527	0.592
1.60	0.461	0.414	0.461
1.80	0.423	0.367	0.423
2.00	0.385	0.329	0.385
2.50	0.323	0.263	0.323
3.00	0.260	0.220	0.260
3.50	0.215	0.188	0.215
4.00	0.170	0.165	0.170
4.50	0.142	0.146	0.146
5.00	0.115	0.132	0.132

The maximum value at each period between 2/3 of the MCEr spectra and 80% of the code design spectra is used for the design spectra.

21.4 DESIGN ACCELERATION PARAMETERS

Where the site-specific procedure is used to determine the design ground motion in accordance with Section 21.3, the parameter S_{DS} shall be taken as 90% of the maximum spectral acceleration, S_a, obtained from the site-specific spectrum, at any period within the range from 0.2 to 5 s, inclusive. The parameter S_{D1} shall be taken as the maximum value of the product, TS_a, for periods from 1 to 2 s for sites with $v_{s,30} > 1{,}200$ ft/s ($v_{s,30} > 365.76$ m/s) and for periods from 1 to 5 s for sites with $v_{s,30} \le 1{,}200$ ft/s ($v_{s,30} \le 365.76$ m/s). The parameters S_{MS} and S_{M1} shall be taken as 1.5 times S_{DS} and S_{D1}, respectively. The values so obtained shall not be less than 80% of the values determined in accordance with Section 11.4.3 for S_{MS} and S_{M1} and Section 11.4.5 for S_{DS} and S_{D1}.

For use with the equivalent lateral force procedure, the site-specific spectral acceleration, S_a, at T shall be permitted to replace S_{D1}/T in Eq. (12.8-3) and $S_{D1}T_L/T^2$ in Eq. (12.8-4). The parameter S_{DS} calculated per this section shall be permitted to be used in Eqs. (12.8-2), (12.8-5), (15.4-1), and (15.4-3). The mapped value of S_1 shall be used in Eqs. (12.8-6), (15.4-2), and (15.4-4).

Period T (sec)	Design S_a (g)	S_a (0.2 to 5 sec)	$T*S_a$ (1 to 2 sec)	$T*S_a$ (1 to 5 sec)
0.01	0.383			
0.02	0.389			
0.03	0.392			
0.05	0.430			
0.08	0.509			
0.10	0.588			
0.15	0.724			
0.20	0.833	0.833		
0.25	0.896	0.896		
0.30	0.940	0.940		
0.40	0.965	0.965		
0.50	0.935	0.935		
0.60	0.882	0.882		
0.70	0.829	0.829		
0.80	0.775	0.775		
0.90	0.721	0.721		
1.00	0.667	0.667	0.667	0.667
1.25	0.592	0.592	0.740	0.740
1.25	0.592	0.592	0.740	0.740
1.60	0.461	0.461	0.738	0.738
1.80	0.423	0.423	0.762	0.762
2.00	0.385	0.385	0.771	0.771
2.50	0.323	0.323		0.807
3.00	0.260	0.260		0.780
3.50	0.215	0.215		0.752
4.00	0.170	0.170		0.679
4.50	0.146	0.146		0.659
5.00	0.132	0.132		0.659
	Max =	**0.965**	**0.771**	**0.807**

21.5 MAXIMUM CONSIDERED EARTHQUAKE GEOMETRIC MEAN (MCE_G) PEAK GROUND ACCELERATION

21.5.1 Probabilistic MCE_G Peak Ground Acceleration. The probabilistic geometric mean peak ground acceleration shall be taken as the geometric mean peak ground acceleration with a 2% probability of exceedance within a 50-year period.

21.5.2 Deterministic MCE_G Peak Ground Acceleration. The deterministic geometric mean peak ground acceleration shall be calculated as the largest 84th-percentile geometric mean peak ground acceleration for characteristic earthquakes on all known active faults within the site region. The deterministic geometric mean peak ground acceleration shall not be taken as lower than 0.5 F_{PGA}, where F_{PGA} is determined using Table 11.8-1 with the value of PGA taken as 0.5g.

21.5.3 Site-Specific MCE_G Peak Ground Acceleration. The site-specific MCE_G peak ground acceleration, PGA_M, shall be taken as the lesser of the probabilistic geometric mean peak ground acceleration of Section 21.5.1 and the deterministic geometric mean peak ground acceleration of Section 21.5.2. The site-specific MCE_G peak ground acceleration shall not be taken as less than 80% of PGA_M determined from Eq. (11.8-1).

Determine S_{DS} and S_{MS}:

$S_{a,max}$ =	0.965	g (from 0.2 to 5 sec)
S_{DS} =	0.869	g (= 0.9 * $S_{a,max}$)
0.8*S_{DS} from code =	0.714	g (from Sect. 11.4.5)
S_{DS} =	0.869	g (max. of the two)
S_{MS} =	1.303	g (= 1.5 * S_{DS})

Determine S_{D1} and S_{M1}:

$V_{S,30}$ =	777	ft/s (use 1 to 5 sec)
S_{D1} = Max. T *S_a =	0.807	g (from 1 to 5 sec)
0.8*S_{D1} from code =	0.659	g (from Sect. 11.4.5)
S_{D1} =	0.807	g (max. of the two)
S_{M1} =	1.210	g (= 1.5 * S_{DS})

Determine PGA_M:

Probabilistic MCE_G PGA =	0.575	g
Deterministic F_{PGA} =	1.100	(Table 11.8-1 @ 0.5g)
½ of Deterministic F_{PGA} =	0.550	
Deterministic MCE_G PGA =	0.914	g
Site-Specific MCE_G PGA =	0.575	g (min. deter. & prob.
0.8 * PGA_M from equation 11.8-1 =	0.588	g (OSHPD webtool)
Design PGA_M =	0.588	g (max. of the two)

USGS web services were down for some period of time and as a result this tool wasn't operational, resulting in *timeout* error.
USGS web services are now operational so this tool should work as expected.

Farmington Regional Center

Latitude, Longitude: 40.9904, -111.9005



Date	7/2/2024, 5:37:56 PM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.338	MCE_R ground motion. (for 0.2 second period)
S_1	0.494	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.338	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	0.892	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F_a	1	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.611	MCE_G peak ground acceleration
F_{PGA}	1.1	Site amplification factor at PGA
PGA_M	0.673	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	1.338	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.548	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.857	Factored deterministic acceleration value. (0.2 second)
S1RT	0.494	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.56	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	1.25	Factored deterministic acceleration value. (1.0 second)
PGAd	1.111	Factored deterministic acceleration value. (Peak Ground Acceleration)
PGA_{UH}	0.611	Uniform-hazard (2% probability of exceedance in 50 years) Peak Ground Acceleration
C_{RS}	0.864	Mapped value of the risk coefficient at short periods
C_{R1}	0.882	Mapped value of the risk coefficient at a period of 1 s
C_V	1.368	Vertical coefficient

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-1

Total Depth: 51.5'
Water Depth: 17'
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown to Brown CLAY (CL) with sand, roots, organics, and mica fragments, moist — medium stiff		1	4 4 2	6								
		grades some gravel		2			21	97				36	21	15
4				3	4 4 2	6								
		grades with oxidation												
		grades gray brown with oxidation and roots		4										
8														
		soft		5	4 3 2	5	32	91			91			
12														
				6										
16		wet												
20				7			31	93	0	19	81	28	20	8
24		Blue Gray Poorly Graded SAND with silt (SP-SM) and gravel, wet — medium dense		8	7 9 15	24								
28														

Remarks: Groundwater encountered during drilling at depth of 17 feet.
Slotted PVC pipe installed to depth of 51.5 feet to facilitate water level measurements.

Coordinates: 40.9904574°, -111.9002282°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 2

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-1

Total Depth: 51.5'
Water Depth: 17'
Date: 5/24/24
Job #: 22203

Depth (ft)	Soil Description	Sample Type	Sample #	Blows (N)	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
				Total			Gravel %	Sand %	Fines %	LL	PL	PI
28	Blue Gray Poorly Graded SAND with silt (SP-SM) and gravel, wet											
	medium dense		9	10 12 15	27	12	31	58	11			
32												
36	grades brown to black — medium dense to dense		10	9 12 18	30							
	Brown Silty SAND (SM) with gravel, wet											
40	grades gray to black — medium dense		11	15 12 5	17	18	12	56	32		NP	NP
	Brown Sandy SILT (ML) with gravel, wet — medium stiff											
44												
	Gray Brown Sandy GRAVEL (GP), wet — loose		12	3 7 9	16	21	111					
48	Gray Brown Sandy CLAY (CL) with oxidation											
	Tan to Gray Brown Poorly Graded SAND with silt (SP-SM) and gravel, oxidation, wet — dense		13	6 12 27	39	10	38	56	6			
52	END AT 51.5'											
56												

Remarks: Groundwater encountered during drilling at depth of 17 feet.
Slotted PVC pipe installed to depth of 51.5 feet to facilitate water level measurements.

Coordinates: 40.9904574°, -111.9002282°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 2

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-2

Total Depth: 16.5'
Water Depth: (see Remarks)
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown to Black Clayey SILT (ML), some sand, roots and organics, moist												
		soft		14	2 1 1	2								
4		grades light brown, sandy with oxidation												
				15	2 2 1	3								
		Light Brown CLAY (CL) with mica, trace sand and oxidation												
		soft		16	3 2 4	6	28	94			90			
8		grades with interbedded layers of sand												
		very soft		17	0 0 0	0								
12														
		soft to medium stiff		18	3 3 5	8	30	85						
16		END AT 16.5'												
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: 40.9902395°, -111.8997712°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 3

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-3

Total Depth: 11.5'
Water Depth: 9.5', 5.6'

Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown to Black Sandy CLAY (CL) with gravel, mica, roots and organics, moist												
		soft		19	3 3 2	5	16	110						
4														
				20			16	115						
8		Brown Silty SAND (SM), moist loose		21	3 4 4	8	25	105	0	69	31			
		wet												
				22										
12		END AT 11.5'												
16														
20														
24														
28														

Remarks: Groundwater encountered during drilling at depth of 9.5 feet and measured on 6/11/24 at depth of 5.6 feet.
Slotted PVC pipe installed to depth of 11.5 feet to facilitate water level measurements.

Coordinates: 40.9900021°, -111.9003489°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 4

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-4

Total Depth: 31.5'
Water Depth: 21'

Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown to Black Clayey SILT (ML) with sand, gravel, roots and organics, moist												
		soft		23	2 2 1	3								
4														
		medium stiff		24	4 3 2	5								
		Gray Brown Sandy CLAY (CL), trace gravel, oxidation and organics, moist												
		soft		25	3 5 2	7	16	107						
8		grades brown with interbedded sand and oxidation												
		soft to medium stiff		26	0 0 4	4								
12														
		soft		27	2 2 4	6	29	95						
16														
20		grades less sand												
		medium stiff to stiff		28	3 3 5	8	29					30	17	13
		wet												
24		Gray Brown Silty SAND (SM) with gravel, wet												
		medium dense		29	12 8 6	14	16		29	53	18			
28														

Remarks: Groundwater encountered during drilling at depth of 21 feet.

Slotted PVC pipe installed to depth of 31.5 feet to facilitate water level measurements.

Coordinates: 40.9907995°, -111.9003818°

Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"

Excavated By: Direct Push Services

Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 5

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-4

Total Depth: 31.5'
Water Depth: 21'

Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
28		Gray Brown Silty SAND (SM) with gravel, wet												
		grades less silt very dense		30	4 20 33	53								
32		END AT 31.5'												
36														
40														
44														
48														
52														
56														

Remarks: Groundwater encountered during drilling at depth of 21 feet.
Slotted PVC pipe installed to depth of 31.5 feet to facilitate water level measurements.

Coordinates: 40.9907995°, -111.9003818°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 5

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-5

Total Depth: 6.5'
Water Depth: (see Remarks)
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown CLAY (CL) with sand and gravel, moist												
		soft		31	3 2 1	3								
4														
		soft to medium stiff		32	1 1 3	4								
		END AT 6.5'												
8														
12														
16														
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: 40.9909273°, -111.8996365°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 6

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-6

Total Depth: 6.5'
Water Depth: (see Remarks)
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown CLAY (CL) with sand, roots and organics, moist												
4		medium stiff		33	0 0 5	5								
		grades with gravel and mica soft		34	1 1 2	3								
		grades with peat												
		END AT 6.5'												
8														
12														
16														
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: 40.9901215°, -111.9008451°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 7

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-7

Total Depth: 6.5'
Water Depth: (see Remarks)
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown Sandy SILT (ML), trace gravel, mica, roots and organics												
		soft		35	3 2 1	3								
4														
		Gray Brown Silty SAND (SM) with gravel and organics, moist medium dense		36	6 5 7	12	7		29	55	16			
		END AT 6.5'												
8														
12														
16														
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: 40.9896923°, -111.900537°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 8

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Bore Hole Log B-8

Total Depth: 6.5'
Water Depth: (see Remarks)
Date: 5/24/24
Job #: 22203

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Dark Brown CLAY (CL) with sand, trace gravel, roots, moist												
		soft		37	3 2 1	3								
4														
		grades trace sand, with mica, oxidation		38	2 1 1	2								
		END AT 6.5'												
8														
12														
16														
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push Services
Logged By: Jake E.

CMT TECHNICAL SERVICES

Figure: 9

Farmington Regional Center

About 500 North Lagoon Drive, Farmington, Utah

Key to Symbols

Date: 5/24/24
Job #: 22203

① Depth (ft)	② GRAPHIC LOG	③ Soil Description	④ Sample Type	⑤ Sample #	Blows(N) ⑥	Blows(N) ⑦ Total	⑧ Moisture (%)	⑨ Dry Density(pcf)	Gradation ⑩ Gravel %	Gradation ⑩ Sand %	Gradation ⑩ Fines %	Atterberg ⑪ LL	Atterberg ⑪ PL	Atterberg ⑪ PI

COLUMN DESCRIPTIONS

① **Depth (ft.):** Depth (feet) below the ground surface (including groundwater depth - see below right).

② **Graphic Log:** Graphic depicting type of soil encountered (see ② below).

③ **Soil Description:** Description of soils, including Unified Soil Classification Symbol (see below).

④ **Sample Type:** Type of soil sample collected; sampler symbols are explained below-right.

⑤ **Sample #:** Consecutive numbering of soil samples collected during field exploration.

⑥ **Blows:** Number of blows to advance sampler in 6" increments, using a 140-lb hammer with 30" drop.

⑦ **Total Blows:** Number of blows to advance sampler the 2nd and 3rd 6" increments.

⑧ **Moisture (%):** Water content of soil sample measured in laboratory (percentage of dry weight).

⑨ **Dry Density (pcf):** The dry density of a soil measured in laboratory (pounds per cubic foot).

⑩ **Gradation:** Percentages of Gravel, Sand and Fines (Silt/Clay), from lab test results of soil passing No. 4 and No. 200 sieves.

⑪ **Atterberg:** Individual descriptions of Atterberg Tests are as follows:

LL = Liquid Limit (%): Water content at which a soil changes from plastic to liquid behavior.

PL = Plastic Limit (%): Water content at which a soil changes from liquid to plastic behavior.

PI = Plasticity Index (%): Range of water content at which a soil exhibits plastic properties (= Liquid Limit - Plastic Limit).

STRATIFICATION	
Description	**Thickness**
Seam	Up to ½ inch
Lense	Up to 12 inches
Layer	Greater than 12 in.
Occasional	1 or less per foot
Frequent	More than 1 per foot

MODIFIERS
Trace
<5%
Some
5-12%
With
> 12%

MOISTURE CONTENT
Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp / moist to the touch, but no visible water.
Saturated: Visible water, usually soil below groundwater.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS SYMBOLS	②	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS: More than 50% of material is larger than No. 200 sieve size.	GRAVELS: The coarse fraction retained on No. 4 sieve.	CLEAN GRAVELS (< 5% fines)	GW		Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP		Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (≥ 12% fines)	GM		Silty Gravels, Gravel-Sand-Silt Mixtures
			GC		Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS: The coarse fraction passing through No. 4 sieve.	CLEAN SANDS (< 5% fines)	SW		Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP		Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (≥ 12% fines)	SM		Silty Sands, Sand-Silt Mixtures
			SC		Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS: More than 50% of material is smaller than No. 200 sieve size.	SILTS AND CLAYS: Liquid Limit less than 50%		ML		Inorganic Silts and Very Fine Sands, Silty or Clayey Fine Sands or Clayey Silts with Slight
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean
			OL		Organic Silts and Organic Silty Clays o f Low Plasticity
	SILTS AND CLAYS: Liquid Limit greater than 50%		MH		Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils with Plasticity (Elastic Silts)
			CH		Inorganic Clays of High Plasticity, Fat Clays
			OH		Organic Silts and Organic Clays of Medium to High Plasticity
HIGHLY ORGANIC SOILS			PT		Peat, Humus, Swamp Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications (i.e. GP-GM, SC-SM, etc.).

SAMPLER SYMBOLS

- Block Sample
- Bulk/Bag Sample
- Modified California Sampler 3.5" OD, 2.42" ID
- D&M Sampler
- Rock Core
- Standard Penetration Split Spoon Sampler
- Thin Wall (Shelby Tube)

WATER SYMBOL

- Encountered Water Level
- Measured Water Level

(see Remarks on Logs)

1. The results of laboratory tests on the samples collected are shown on the logs at the respective sample depths.
2. The subsurface conditions represented on the logs are for the locations specified. Caution should be exercised if interpolating between or extrapolating beyond the exploration locations.
3. The information presented on each log is subject to the limitations, conclusions, and recommendations presented in this report.

CMT TECHNICAL SERVICES

Figure: 10

SECTION 007200 - GENERAL CONDITIONS

FORM OF GENERAL CONDITIONS

1.01 THE GENERAL CONDITIONS APPLICABLE TO THIS CONTRACT IS ATTACHED FOLLOWING THIS PAGE.

RELATED REQUIREMENTS

2.01 SECTION 007300 - SUPPLEMENTARY CONDITIONS.

END OF SECTION 007200

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DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 007300 - SUPPLEMENTARY CONDITIONS

PART 1 GENERAL

1.01 SUMMARY

A. These Supplementary Conditions amend and supplement the General Conditions defined in Document 007200 - General Conditions and other provisions of Contract Documents as indicated below. Provisions that are not so amended or supplemented remain in full force and effect.

B. The terms used in these Supplementary Conditions that are defined in the General Conditions have the meanings assigned to them in the General Conditions.

1.02 MODIFICATIONS TO GENERAL CONDITIONS

A. The following DFCM "Supplemental General Conditions" follow this cover page:

1. Form 071508 "Supplemental General Conditions for Construction Agreements". Dated July 15, 2008
2. Form 070110 "Supplemental General Conditions for Drug and Alcohol Testing". Dated July 1, 2010.
3. Form 070109 "Supplemental General Conditions regarding Illegal Immigration". Dated May 10, 2011.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 007300

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SECTION 011000 - SUMMARY

PART 1 GENERAL

1.01 PROJECT

A. Project Name: DFCM REGIONAL CENTER - FARMINGTON

B. Owner's Name: Division of Facilities and Construction Management.

C. Architect's Name: ajc architects.

D. The Project consists of the construction of A new DFCM building for the State of Utah will house several agencies including: Department of Motor Vehicles, Driver License Division, Health and Human Services and Department of Workforce Services. The project will be constructed of structural steel frame, with masonry veneer and metal panel exterior façade. The project will also consist of interior finishes, mechanical systems, electrical systems, and site improvements as outlined in the construction documents..

1.02 CONTRACT DESCRIPTION

A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 005200 - Agreement Form.

1.03 OWNER OCCUPANCY

A. Owner intends to occupy the Project upon Substantial Completion.

B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

C. Schedule the Work to accommodate Owner occupancy.

1.04 CONTRACTOR USE OF SITE AND PREMISES

A. Construction Operations: Limited to areas noted on Drawings.

1. Locate and conduct construction activities in ways that will limit disturbance to site.

B. Provide access to and from site as required by law and by Owner:

1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
2. Do not obstruct roadways, sidewalks, or other public ways without permit.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 011000

SECTION 012000 - PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

B. Documentation of changes in Contract Sum and Contract Time.

C. Change procedures.

D. Correlation of Contractor submittals based on changes.

E. Procedures for preparation and submittal of application for final payment.

1.02 RELATED REQUIREMENTS

A. Section 017800 - Closeout Submittals: Project record documents.

1.03 SCHEDULE OF VALUES

A. Use Schedule of Values Form: AIA G703, edition stipulated in the Agreement.

B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.

C. Forms filled out by hand will not be accepted.

D. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.

E. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification section. Identify site mobilization.

F. Include in each line item, the amount of Allowances specified in this section. For unit cost Allowances, identify quantities taken from Contract Documents multiplied by the unit cost to achieve the total for the item.

G. Include separately from each line item, a direct proportional amount of Contractor's overhead and profit.

H. Revise schedule to list approved Change Orders, with each Application For Payment.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

A. Payment Period: Submit at intervals stipulated in the Agreement.

B. Use Form DFCM Application and Certificate for Payment as form for Applications for Payment..

C. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.

D. Forms filled out by hand will not be accepted.

E. For each item, provide a column for listing each of the following:

1. Item Number.

2. Description of work.

3. Scheduled Values.

4. Previous Applications.

5. Work in Place and Stored Materials under this Application.

6. Authorized Change Orders.

7. Total Completed and Stored to Date of Application.

8. Percentage of Completion.

9. Balance to Finish.

10. Retainage.

F. Execute certification by signature of authorized officer.

G. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.

H. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of work.

I. Submit one electronic and one hard-copies of each Application for Payment.

J. Include the following with the application:

1. Transmittal letter as specified for submittals in Section 013000.
2. Construction progress schedule revised and current as specified in Section 013000.

K. When Architect requires substantiating information, submit data justifying dollar amounts in question. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

1.05 MODIFICATION PROCEDURES

A. For minor changes not involving an adjustment to the Contract Sum or Contract Time, Architect will issue instructions directly to Contractor.

B. For other required changes, Architect will issue a document signed by Owner instructing Contractor to proceed with the change, for subsequent inclusion in a Change Order.

1. The document will describe the required changes and will designate method of determining any change in Contract Sum or Contract Time.
2. Promptly execute the change.

C. For changes for which advance pricing is desired, Architect will issue a document that includes a detailed description of a proposed change with supplementary or revised drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within 10 days.

D. Contractor may propose a change by submitting a request for change to Architect, describing the proposed change and its full effect on the work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation. Document any requested substitutions in accordance with Section 016000.

1. Proposal Request Form: Use DFMC Proposal Request Form.

E. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.

F. Substantiation of Costs: Provide full information required for evaluation.

1. Provide the following data:

a. Taxes, insurance, and bonds.
b. Overhead and profit.
c. Justification for any change in Contract Time.
d. Credit for deletions from Contract, similarly documented.

2. Support each claim for additional costs with additional information:

a. Origin and date of claim.
b. Dates and times work was performed, and by whom.
c. Time records and wage rates paid.

d. Invoices and receipts for products, equipment, and subcontracts, similarly documented.

3. For Time and Material work, submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.

G. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

H. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.

I. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.

J. Promptly enter changes in Project Record Documents.

1.06 APPLICATION FOR FINAL PAYMENT

A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.

B. Application for Final Payment will not be considered until the following have been accomplished:

1. All closeout procedures specified in Section 017000.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid..
3. DFCM Project Closeout Checklist.
4. DFCM Consent of Surety to Final Payment..
5. DFCM Application and Certificate for Payment.
6. Evidence that claims have been settled.
7. Final liquidated damages settlement statement.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012000

SECTION 012300 - ALTERNATES

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 administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include, as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other Work of the Contract.

C. Schedule: A Part 3 "Schedule of Alternates" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1: CDL Range Area.

1. Base Bid: Site Plan as indicated on Drawing AS101.
2. Alternate: Add site development for CDL Range as indicated on Drawing AS101.

B. Alternate No. 2: Additional parking area with 19 stalls, concrete curb and gutter, Island, asphalt paving and site lighting.

1. Base Bid: Site Plan as indicated on Drawing AS101.
2. Alternate: Add site development for additional parking area as indicated on Drawing AS101.

C. Alternate No. 3: Six (6) additional Electric vehicle charging stations with double plugs, EV Charging Station signs and bollards.

1. Base Bid: Site Plan as indicated on Drawing AS101 and Electrical Drawings.
2. Alternate: Add (6) additional EV Charging Stations area as indicated on Drawing AS101.

END OF SECTION 012300

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

A. Section 012500.01 - Substitution Request Form - During Construction: Required form for substitution requests made after award of contract (During construction).

B. Section 013000 - Administrative Requirements: Submittal procedures, coordination.

C. Section 016000 - Product Requirements: Fundamental product requirements, product options, delivery, storage, and handling.

1.03 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.
    b. Regulatory changes.

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.

1.04 REFERENCE STANDARDS

A. CSI/CSC Form 13.1A - Substitution Request (After the Bidding/Negotiating Phase); Current Edition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 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.

1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 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 within 14 days of 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. Without a separate written request.

3. When acceptance will require revisions to Contract Documents.

3.03 RESOLUTION

A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.

B. Architect will notify Contractor in writing of decision to accept or reject request.

1. Architect's decision following review of proposed substitution will be noted on the submitted form.

3.04 ACCEPTANCE

A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

3.05 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. Include completed Substitution Request Forms as part of the Project record. Include both approved and rejected Requests.

END OF SECTION 012500

SECTION 013000 - ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General administrative requirements.

B. Web-based project software service.

C. Electronic document submittal service.

D. Preconstruction meeting.

E. Site mobilization meeting.

F. Progress meetings.

G. Construction progress schedule.

H. Contractor's daily reports.

I. Progress photographs.

J. Coordination drawings.

K. Submittals for review, information, and project closeout.

L. Number of copies of submittals.

M. Requests for Interpretation (RFI) procedures.

N. Submittal procedures.

1.02 RELATED REQUIREMENTS

A. Section 017800 - Closeout Submittals: Project record documents; operation and maintenance data; warranties and bonds.

B. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Comply with requirements of Section 017000 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.

B. Make the following types of submittals to Architect:

1. Requests for Information (RFI).
2. Requests for substitution.
3. Shop drawings, product data, and samples.
4. Sustainable Design Requirements.
5. Test and inspection reports.
6. Design data.
7. Manufacturer's instructions and field reports.
8. Applications for payment and change order requests.
9. Progress schedules.
10. Coordination drawings.
11. Correction Punch List and Final Correction Punch List for Substantial Completion.
12. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 WEB-BASED PROJECT SOFTWARE SERVICE

A. Web-Based Project Software Service: Provide, administer, and use web-based project software to host and manage project communication and documentation.

1. Include, at minimum, the following features:

a. Project directory, including Owner, Contractor, subcontractors, Architect, Architect's consultants, and other entities involved in the project. Include names of contact persons and contact information for each entity.
b. Access control for each entity and for each workflow process to determine each entity's digital rights to create, modify, view, and print documents.
c. Workflow planning, allowing customization of workflow for each project entity.
d. Creation, logging, tracking, and notification for project communications.
e. Tracking of project communication statuses in real time, including timestamped response log.
f. Procedures for viewing PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
g. Processing and tracking of payment applications.
h. Processing and tracking of contract modifications.
i. Creation and distribution of meeting minutes.
j. Document management for drawings, specifications, and coordination drawings, including revision control.
k. Management of construction progress photographs.
l. Mobile device compatibility.
m. Creation of data analytics reports.

n. Creation and export of editable logs for software functions. Provide Owner, Architect, and Architect's consultants with rights and ability to download logs when requested.

2. Provide up to 20 user licenses for use by Owner, Architect, Architect's consultants, and other entities involved in the project.
3. Comply with the software service's current published licensing agreements.
4. Training: Provide one-hour, web-based training session for users of software service. Further training is the responsibility of the user.

   a. Representatives of Owner are scheduled and included in this training.

5. Project Closeout: Architect determines when to terminate the software service for the project and is responsible for obtaining archive copies of files for Owner.
6. Web-Based Project Software Services: The selected service is:

3.02 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.

   1. 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.
   2. Contractor and Architect are required to use this service.
   3. It is Contractor's responsibility to submit documents in allowable format.
   4. Subcontractors, suppliers, and Architect's consultants are to be permitted to use the service at no extra charge.
   5. 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.
   6. Paper document transmittals will not be reviewed; emailed electronic documents will not be reviewed.
   7. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.

B. Cost: The cost of the service is to be paid by Contractor; include the cost of the service in the Contract Sum.

C. 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.

D. Project Closeout: Architect will determine when to terminate the service for the project and is responsible for obtaining archive copies of files for Owner.

3.03 PRECONSTRUCTION MEETING

A. Schedule meeting after Notice of Award.

B. Attendance Required:

1. Owner.
2. Architect.
3. Contractor.

C. Agenda:

1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
5. Designation of personnel representing the parties to Contract, and Architect.
6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
7. Scheduling.

D. 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.

3.04 SITE MOBILIZATION MEETING

A. Schedule meeting at the Project site prior to Contractor occupancy.

B. Attendance Required:

1. Contractor.
2. Owner.
3. Architect.
4. Contractor's superintendent.
5. Major subcontractors.

C. Agenda:

1. Use of premises by Owner and Contractor.
2. Owner's requirements.

3. Construction facilities and controls provided by Owner.
4. Temporary utilities provided by Owner.
5. Survey and building layout.
6. Security and housekeeping procedures.
7. Schedules.
8. Application for payment procedures.
9. Procedures for testing.
10. Procedures for maintaining record documents.
11. Requirements for start-up of equipment.
12. Inspection and acceptance of equipment put into service during construction period.

D. 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.

3.05 PROGRESS MEETINGS

A. Architect will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

1. Record attendees on **DFCM Meeting Attendance Log**.

B. Attendance Required:

1. Contractor.
2. Owner.
3. Architect.
4. Contractor's superintendent.
5. Major subcontractors.

C. Agenda:

1. Review minutes of previous meetings.
2. Review of work progress.
3. Field observations, problems, and decisions.
4. Identification of problems that impede, or will impede, planned progress.
5. Review of submittals schedule and status of submittals.
6. Review of RFIs log and status of responses.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Maintenance of quality and work standards.
11. Effect of proposed changes on progress schedule and coordination.
12. Other business relating to work.

D. Record minutes and distribute copies within three working days days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

1. Record minutes using **DFCM Meeting Minutes Form**

3.06 CONSTRUCTION PROGRESS SCHEDULE

A. If preliminary schedule requires revision after review, submit revised schedule within 10 days.

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. Within 10 days after joint review, submit complete schedule.

D. Submit updated schedule with each Application for Payment.

3.07 DAILY CONSTRUCTION REPORTS

A. Include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.

B. In addition to transmitting electronically a copy to Owner and Architect, submit two printed copies at weekly intervals.

1. Submit in format acceptable to Owner.

C. Prepare a daily construction report recording the following information concerning events at Project site and project progress:

1. Date.
2. High and low temperatures, and general weather conditions.
3. List of subcontractors at Project site.
4. Major equipment at Project site.
5. Material deliveries.
6. Safety, environmental, or industrial relations incidents.
7. Meetings and significant decisions.
8. Stoppages, delays, shortages, and losses. Include comparison between scheduled work activities (in Contractor's most recently updated and published schedule) and actual activities. Explain differences, if any. Note days or periods when no work was in progress and explain the reasons why.
9. Testing and/or inspections performed.
10. Signature of Contractor's authorized representative.

3.08 PROGRESS PHOTOGRAPHS

A. Maintain one set of all photographs at project site for reference; same copies as submitted, identified as such.

B. Photography Type: Digital; electronic files.

C. In addition to periodic, recurring views, take photographs of each of the following events:

1. Completion of site clearing.
2. Excavations in progress.
3. Foundations in progress and upon completion.
4. Structural framing in progress and upon completion.
5. Enclosure of building, upon completion.
6. Final completion, minimum of ten (10) photos.

D. Digital Photographs: 24 bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.

1. Delivery Medium: Via email.
2. File Naming: Include project identification, date and time of view, and view identification.
3. PDF File: Assemble all photos into printable pages in PDF format, with 2 to 3 photos per page, each photo labeled with file name; one PDF file per submittal.

3.09 COORDINATION DRAWINGS

A. Provide information required by Project Coordinator for preparation of coordination drawings.

B. Review drawings prior to submission to Architect.

3.10 REQUESTS FOR INFORMATION (RFI)

A. Definition: A request seeking one of the following:

1. 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.
2. A resolution to an issue which has arisen due to field conditions and affects design intent.

B. 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.

C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.

1. Prepare a separate RFI for each specific item.

a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
b. Do not forward requests which solely require internal coordination between subcontractors.

2. Prepare in a format and with content acceptable to Owner.
   a. Use **DFCM RFI Form** - Request for Interpretation.

3. Prepare using an electronic version of the form appended to this section.
4. Prepare using software provided by the Electronic Document Submittal Service.
5. Combine RFI and its attachments into a single electronic file. PDF format is preferred.

D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.

1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.

2. Unacceptable Uses for RFIs: Do not use RFIs to request the following::

   a. Approval of submittals (use procedures specified elsewhere in this section).
   b. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
   c. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).

3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.

   a. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect, and any of its consultants, due to processing of such RFIs.

E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.

1. Official Project name and number, and any additional required identifiers established in Contract Documents.
2. Owner's, Architect's, and Contractor's names.
3. Discrete and consecutive RFI number, and descriptive subject/title.
4. Issue date, and requested reply date.
5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).

6. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.

F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

G. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.

1. Indicate current status of every RFI. Update log promptly and on a regular basis.
2. Note dates of when each request is made, and when a response is received.
3. Identify and include improper or frivolous RFIs.

H. Review Time: Architect will respond and return RFIs to Contractor within fourteen (14) calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.

1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.

I. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.

1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
4. Notify Architect within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.11 SUBMITTAL SCHEDULE

A. Submit to Architect for review a schedule for submittals in tabular format.

1. Format schedule to allow tracking of status of submittals throughout duration of construction.
2. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.

3. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.

    a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.

3.12 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:

1. Product data.
2. Shop drawings.
3. Samples for selection.
4. Samples for verification.

B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 - Closeout Submittals.

3.13 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:

1. Design data.
2. Certificates.
3. Test reports.
4. Inspection reports.
5. Manufacturer's instructions.
6. Manufacturer's field reports.
7. Other types indicated.

B. Submit for Architect's knowledge as contract administrator or for Owner.

3.14 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 017800 - Closeout Submittals:

1. Project record documents.
2. Operation and maintenance data.
3. Warranties.
4. Bonds.
5. Other types as indicated.

D. Submit for Owner's benefit during and after project completion.

3.15 NUMBER OF COPIES OF SUBMITTALS

A. 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.

B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.

1. After review, produce duplicates.
2. Retained samples will not be returned to Contractor unless specifically so stated.

3.16 SUBMITTAL PROCEDURES

A. General Requirements:

1. Use a single transmittal for related items.
2. Transmit using approved form.

    a. Use Form CSI/CSC Form 12.1A.

3. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
4. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
5. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.

    a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.

6. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.

    a. Upload submittals in electronic form to Electronic Document Submittal Service website.

7. Schedule submittals to expedite the Project, and coordinate submission of related items.

    a. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
    b. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.
    c. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Architect's approval, allow an additional 30 days.

8. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
9. Provide space for Contractor and Architect review stamps.
10. When revised for resubmission, identify all changes made since previous submission.
11. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
12. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
13. Submittals not requested will not be recognized or processed.

B. Product Data Procedures:

1. Submit only information required by individual specification sections.
2. Collect required information into a single submittal.
3. Submit concurrently with related shop drawing submittal.
4. Do not submit (Material) Safety Data Sheets for materials or products.

C. Shop Drawing Procedures:

1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
2. Do not reproduce Contract Documents to create shop drawings.
3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Samples Procedures:

1. Transmit related items together as single package.
2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.17 SUBMITTAL REVIEW

A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.

B. Submittals for Information: Architect will acknowledge receipt, but will take no other action.

C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.

D. Architect's and consultants' actions on items submitted for review:

1. Authorizing purchasing, fabrication, delivery, and installation:

a. "Approved", or language with same legal meaning.
b. "Approved as Noted, Resubmission not required", or language with same legal meaning.

1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.

c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.

1) Resubmit corrected item, with review notations acknowledged and incorporated. Resubmit separately, or as part of project record documents.

2. Not Authorizing fabrication, delivery, and installation:

a. "Revise and Resubmit".

1) Resubmit revised item, with review notations acknowledged and incorporated.
2) Non-responsive resubmittals may be rejected.

b. "Rejected".

1) Submit item complying with requirements of Contract Documents.

E. Architect's and consultants' actions on items submitted for information:

1. Items for which no action was taken:

a. "Received" - to notify the Contractor that the submittal has been received for record only.

2. Items for which action was taken:

a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 013000

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SECTION 013216 - CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preliminary schedule.

B. Construction progress schedule, with network analysis diagrams and reports.

1.02 RELATED SECTIONS

A. Section 011000 - Summary: Occupancy.

1.03 SUBMITTALS

A. Within 10 days after date of Agreement, submit preliminary schedule.

B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.

C. 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.

D. Within 10 days after joint review, submit complete schedule.

E. Submit updated schedule with each Application for Payment.

F. Submit in PDF format.

1.04 QUALITY ASSURANCE

A. Scheduler: Contractor's personnel or specialist Consultant specializing in CPM scheduling with one years minimum experience in scheduling construction work of a complexity comparable to this Project, and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

1.05 SCHEDULE FORMAT

A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.

B. Diagram Sheet Size: Maximum 22 x 17 inches.

C. Scale and Spacing: To allow for notations and revisions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE

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

3.02 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. Identify work of separate stages and other logically grouped activities.

D. Include conferences and meetings in schedule.

E. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.

F. Provide separate schedule of submittal dates for shop drawings, product data, and samples, owner-furnished products, products identified under Allowances, and dates reviewed submittals will be required from Architect. Indicate decision dates for selection of finishes.

G. Coordinate content with schedule of values specified in Section 012000 - Price and Payment Procedures.

H. Provide legend for symbols and abbreviations used.

3.03 BAR CHARTS

A. Include a separate bar for each major portion of Work or operation.

B. Identify the first work day of each week.

3.04 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.
3. Listing of activities on the critical path.

3.05 REVIEW AND EVALUATION OF SCHEDULE

A. Participate in joint review and evaluation of schedule with Architect at each submittal.

B. Evaluate project status to determine work behind schedule and work ahead of schedule.

C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.06 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.

3.07 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 014000 - QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittals.

B. Quality assurance.

C. References and standards.

D. Testing and inspection agencies and services.

E. Contractor's construction-related professional design services.

F. Contractor's design-related professional design services.

G. Control of installation.

H. Mock-ups.

I. Tolerances.

J. Manufacturers' field services.

K. Defect Assessment.

1.02 RELATED REQUIREMENTS

A. Document 003100 - Available Project Information: Soil investigation data.

B. Section 012100 - Allowances: Allowance for payment of testing services.

C. Section 013000 - Administrative Requirements: Submittal procedures.

D. Section 016000 - Product Requirements: Requirements for material and product quality.

E. Section 018113.14 – Sustainable Design Requirements – HPBS.

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.
b. Design-Related: Design services explicitly required to be performed by another design professional due to highly-technical and/or specialized nature of a portion of the project. Services primarily involve engineering analysis, calculations, and design, and are not intended to alter the aesthetic aspects of the design.

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 CONTRACTOR'S CONSTRUCTION-RELATED PROFESSIONAL DESIGN SERVICES

A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.

B. Provide such engineering design services as may be necessary to plan and safely conduct certain construction operations, pertaining to, but not limited to the following:

1. Temporary scaffolding.
2. Temporary hoist(s) and rigging.

1.05 CONTRACTOR'S DESIGN-RELATED PROFESSIONAL DESIGN SERVICES

A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.

B. Base design on performance and/or design criteria indicated in individual specification sections.

C. Scope of Contractor's Professional Design Services: Provide for the following items of work:

1. Structural Design of Steel Decking: As described in Section 053100 - Steel Decking.
2. Structural Design of Metal Framing: As described in Section 054000 - Cold-Formed Metal Framing.
3. Structural Design of Metal Fabrications: As described in Section 055000 - Metal Fabrications.

4. Structural Design: Include physical characteristics, engineering calculations, and resulting dimensional limitations as described in Section 084313 - Aluminum-Framed Storefronts.
5. Structural Design of Foundation: As described in Section 107500 - Flagpoles.

1.06 SUBMITTALS

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

B. See Section 018113.14 – Sustainable Design Requirements – HPBS.

C. Designer's Qualification Statement: Submit for Architect's knowledge as contract administrator, or for Owner's information.

1. Include information for each individual professional responsible for producing, or supervising production of, design-related professional services provided by Contractor.

a. Full name.
b. Professional licensure information.
c. Statement addressing extent and depth of experience specifically relevant to design of items assigned to Contractor.

D. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.

1. Include calculations that have been used to demonstrate compliance to performance and regulatory criteria provided, and to determine design solutions.
2. Include required product data and shop drawings.
3. Include a statement or certification attesting that design data complies with criteria indicated, such as building codes, loads, functional, and similar engineering requirements.
4. Include signature and seal of design professional responsible for allocated design services on calculations and drawings.

E. Test Reports: After each test/inspection, promptly submit two copies of report to Architect and to Contractor.

1. Include:

a. Date issued.
b. Project title and number.
c. Name of inspector.
d. Date and time of sampling or inspection.
e. Identification of product and specifications section.
f. Location in the Project.
g. Type of test/inspection.
h. Date of test/inspection.

i. Results of test/inspection.
j. Compliance with Contract Documents.
k. When requested by Architect, provide interpretation of results.

2. Test report submittals are for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.

F. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.

1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect.

G. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

H. Manufacturer's Field Reports: Submit reports for Architect's benefit as contract administrator or for Owner.

1. Submit report within 30 days of observation to Architect for information.
2. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.

I. Erection Drawings: Submit drawings for Architect's benefit as contract administrator or for Owner.

1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.
2. Data indicating inappropriate or unacceptable Work may be subject to action by Architect or Owner.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Prior to start of work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.

B. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of Contractor by Contract Documents, provide services of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

C. Contractor's Quality Control (CQC) Plan:

1. Prior to start of work, submit a comprehensive plan describing how contract deliverables will be produced. Tailor CQC plan to specific requirements of the project. Include the following information:

a. Management Structure: Identify personnel responsible for quality. Include a chart showing lines of authority.
b. Management Approach: Define, describe, and include in the plan specific methodologies used in executing the work.

1) Management and control of documents and records relating to quality.
2) Communications.
3) Coordination procedures.
4) Resource management.
5) Process control.
6) Inspection and testing procedures and scheduling.
7) Control of noncomplying work.
8) Tracking deficiencies from identification, through acceptable corrective action, and verification.
9) Control of testing and measuring equipment.
10) Managerial continuity and flexibility.

D. Quality-Control Personnel Qualifications. Engage a person with requisite training and experience to implement and manage quality assurance (QA) and quality control (QC) for the project.

1.08 REFERENCES AND STANDARDS

A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.

C. Obtain copies of standards where required by product specification sections.

D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

E. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.

F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from Contract Documents by mention or inference otherwise in any reference document.

1.09 TESTING AND INSPECTION AGENCIES AND SERVICES

A. Owner will employ services of an independent testing agency to perform certain specified testing; payment for cost of services will be derived from allowance specified in Section 012100; see Section 012100 and applicable sections for description of services included in allowance.

B. Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.

C. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

D. Contractor Employed Agency:

1. Testing agency: Comply with requirements of ASTM E329, ASTM E543, ASTM E699, ASTM C1021, ASTM C1077, ASTM C1093, ASTM D3740, and other appropriate requirements as outlined in individual sections.
2. Testing Equipment: Calibrated at reasonable intervals either by NIST or using an NIST established Measurement Assurance Program, under a laboratory measurement quality assurance program.

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. Integrated Exterior Mock-ups: Construct integrated exterior mock-up as indicated on drawings. Coordinate installation of exterior envelope materials and products as required in individual Specification Sections. Provide adequate supporting structure for mock-up materials as necessary.

B. Notify Architect and applicable Consultant fifteen (15) working days in advance of dates and times when mock-ups will be constructed.

C. Provide supervisory personnel who will oversee mock-up construction. Provide workers that will be employed during the construction at Project.

D. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.

E. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

F. Obtain Architect's approval of mock-ups before starting work, fabrication, or construction.

1. Architect will issue written comments within seven (7) working days of initial review and each subsequent follow up review of each mock-up.
2. Make corrections as necessary until Architect's approval is issued.

G. Architect will use accepted mock-ups as a comparison standard for the remaining Work.

H. 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 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

3.04 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.

3.05 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Architect 30 days in advance of required observations.

1. Observer subject to approval of Owner.

C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.06 DEFECT ASSESSMENT

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

B. If, in the opinion of Architect or Owner, it is not practical to remove and replace the work, Architect or Owner will direct an appropriate remedy or adjust payment.

END OF SECTION 014000

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SECTION 015000 – TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Sections include the following:

1. Division 1 Section "Summary" for limitations on utility interruptions and other work restrictions.

2. Division 1 Section "Execution Requirements" for progress cleaning requirements.

3. Divisions 2 through 16 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.

1.3 DEFINITIONS

A. Permanent Enclosure: As determined by Architect, permanent or temporary roofing is complete, insulated, and weather tight; exterior walls are insulated and weather tight; and all openings are closed with permanent construction or substantial temporary closures.

1.4 USE CHARGES

A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.

B. Sewer Service: none required.

C. Electric Power Service: Contractor shall be responsible to provide temporary electric power as may be required for all entities of construction operations with approval from the Owner.

D. Water Service: Water from the Owner will not be available for contractor use. Provide connections and extensions of service as required for construction operations from off-site water sources.

1.5 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.

1.6 TEMPORARY FACILITIES

A. Field Offices: NONE REQUIRED.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 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.

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.

3.2 TEMPORARY UTILITY INSTALLATION

A. Water Service: Water for construction must be obtained from off-site sources.

B. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

C. Electric Power Service: Provide temporary electric power service (generator) and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

D. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel.

1. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

3.3 SUPPORT FACILITY INSTALLATION

A. Parking: Use designated areas of Owner's existing parking areas for construction personnel.

B. 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 nor endanger permanent Work or temporary facilities.

2. Remove snow and ice as required to minimize accumulations.

C. Waste Disposal Facilities: Comply with requirements specified in Division 1 Section "Construction Waste Management."

D. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with Division 1 Section "Execution Requirements" for progress cleaning requirements.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that 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 Division 1 Section "Summary."

B. Temporary Erosion and Sedimentation Control: Comply with requirements specified in Division 2 Section "Site Clearing."

C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff an airborne dust to adjacent properties and walkways according to requirements of authorities having jurisdiction.

D. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

E. Stormwater Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

F. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

END OF SECTION 015000

SECTION 015100 - TEMPORARY UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary Utilities: Provision of electricity, lighting, heat, and water.

1.02 TEMPORARY ELECTRICITY

A. Cost: By Contractor.

B. Provide power service required from utility source.

C. Power Service Characteristics: 120/208 volt, 400 ampere, three phase, four wire.

D. Provide power outlets for construction operations, with branch wiring and distribution boxes located at each floor. Provide flexible power cords as required.

E. Provide main service disconnect and over-current protection at convenient location and meter.

F. Permanent convenience receptacles may be utilized during construction.

G. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting.

1.03 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain LED, compact fluorescent, or high-intensity discharge lighting as suitable for the application for construction operations in accordance with requirements of 29 CFR 1926 and authorities having jurisdiction.

B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.

C. Maintain lighting and provide routine repairs.

1.04 TEMPORARY HEATING

A. Cost of Energy: By Contractor.

B. Provide heating devices and heat as needed to maintain specified conditions for construction operations.

C. Maintain minimum ambient temperature of 50 degrees F in areas where construction is in progress, unless indicated otherwise in specifications.

D. Prior to operation of permanent equipment for temporary heating purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.

1.05 TEMPORARY COOLING

A. Cost of Energy: By Contractor.

B. Provide cooling devices and cooling as needed to maintain specified conditions for construction operations.

C. Maintain maximum ambient temperature of 80 degrees F in areas where construction is in progress, unless indicated otherwise in specifications.

D. Prior to operation of permanent equipment for temporary cooling purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.

1.06 TEMPORARY WATER SERVICE

A. Cost of Water Used: By Contractor.

B. Provide and maintain suitable quality water service for construction operations at time of project mobilization.

C. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 015100

SECTION 015213 - FIELD OFFICES AND SHEDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary field offices for use of Contractor, Owner and Architect.

1.02 RELATED REQUIREMENTS

A. Section 015000 - Temporary Facilities and Controls:

1.03 USE OF PERMANENT FACILITIES

A. When permanent facilities are enclosed with operable utilities, relocate offices into building, with written agreement of Owner, and remove temporary buildings.

PART 2 PRODUCTS

2.01 CONSTRUCTION

A. Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations, with steps and landings at entrance doors.

B. Construction: Structurally sound, secure, weather tight enclosures for office. Maintain during progress of Work; remove when no longer needed.

C. Temperature Transmission Resistance of Floors, Walls, and Ceilings: Compatible with occupancy requirements.

D. Fire Extinguishers: Appropriate type fire extinguisher at each office.

2.02 ENVIRONMENTAL CONTROL

A. Heating, Cooling, and Ventilating: Automatic equipment to maintain comfort conditions.

2.03 CONTRACTOR OFFICE AND FACILITIES

A. Size: For Contractor's needs and to provide space for project meetings.

B. Other Furnishings: Contractor's option.

PART 3 EXECUTION

3.01 PREPARATION

A. Fill and grade sites for temporary structures to provide drainage away from buildings.

3.02 INSTALLATION

A. Install office spaces ready for occupancy 15 days after date fixed in Notice to Proceed.

3.03 MAINTENANCE AND CLEANING

A. Maintain approach walks free of mud, water, and snow.

3.04 REMOVAL

A. At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

END OF SECTION 015213

SECTION 015500 - VEHICULAR ACCESS AND PARKING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Access roads.

B. Parking.

C. Construction parking controls.

D. Flag persons.

E. Haul routes.

F. Maintenance.

G. Removal, repair.

H. Mud from site vehicles.

PART 2 PRODUCTS

2.01 MATERIALS

A. Temporary Construction: As indicated and required by project.

B. Materials for Permanent Construction: As specified in product specification sections, including earthwork, paving base, and topping.

PART 3 EXECUTION

3.01 PREPARATION

A. Clear areas, provide surface and storm drainage of road, parking, area premises, and adjacent areas.

3.02 ACCESS ROADS

A. Construct new temporary all-weather access roads from public thoroughfares to serve construction area, of a width and load bearing capacity to provide unimpeded traffic for construction purposes.

B. Extend and relocate as work progress requires, provide detours as necessary for unimpeded traffic flow.

C. Provide unimpeded access for emergency vehicles. Maintain 20 foot width driveways with turning space between and around combustible materials.

3.03 PARKING

A. Arrange for temporary parking areas to accommodate use of construction personnel.

B. When site space is not adequate, provide additional off-site parking.

3.04 CONSTRUCTION PARKING CONTROL

A. Control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and Owner's operations.

3.05 FLAG PERSONS

A. Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.

3.06 HAUL ROUTES

A. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.

B. Confine construction traffic to designated haul routes.

C. Provide traffic control at critical areas of haul routes to regulate traffic, to minimize interference with public traffic.

3.07 MAINTENANCE

A. Maintain traffic and parking areas in a sound condition free of excavated material, construction equipment, products, mud, snow, and ice.

B. Maintain existing paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

3.08 REMOVAL, REPAIR

A. Remove equipment and devices when no longer required.

B. Repair damage caused by installation.

3.09 MUD FROM SITE VEHICLES

A. Provide means of removing mud from vehicle wheels before entering streets.

END OF SECTION 015500

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SECTION 01 5639 - TREE PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the protection and trimming of trees that interfere with, or are affected by, execution of the Work, whether temporary or new construction.

A. List below only construction that the reader might expect to find in this Section but is specified elsewhere.

B. Related Sections include the following:

1. Division 01 Summary of Work for limits placed on Contractor's use of the site.
2. Division 01 Temporary Facilities and Controls for temporary tree protection.
3. Division 02 Selective Demolition for removal limits of trees, shrubs, and other plantings affected by new construction.
4. Division 31 Earthwork for building and utility trench excavation, backfilling, compacting and grading requirements, and soil materials.
5. Division 32 Landscaping Planting for tree and shrub planting and transplanting, tree support systems, and soil materials.

If alternates, allowances, or unit prices apply to work of this Section, insert brief paragraphs here to alert Contractor and reference appropriate Division 1 Sections for specific details.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Certification: From a qualified arborist that trees indicated to remain have been protected during all phases of construction according to recognized standards and those trees were promptly and properly treated and repaired when damaged.

D. Maintenance Recommendations: From a qualified arborist for care and protection of trees affected by construction during and after completing the Work.

1.4 QUALITY ASSURANCE

Revise or delete paragraph and subparagraph below if not required or available at Project location.

A. Tree Service Qualifications: An experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

B. Arborist Qualifications: An arborist certified by the International Society of Arboriculture or licensed in the jurisdiction where Project is located.

C. Tree Pruning Standards: Comply with ANSI A300, "Trees, Shrubs, and Other Woody Plant Maintenance--Standard Practices," unless more stringent requirements are indicated.

Delete paragraph below if work of this Section is not extensive or complex enough to justify a preinstallation conference. If retaining, coordinate with Division 1 Section "Project Meetings."

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

Revise paragraph above and subparagraph below to suit Project. Delete if not required.

1. Before starting tree protection and trimming, meet with representatives of authorities having jurisdiction, Owner, Architect, consultants, and other concerned entities. Review tree protection and trimming procedures and responsibilities. Notify participants at least three working days before convening conference. Record discussions and agreements and furnish a copy to each participant.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Drainage Fill: Selected crushed stone, or crushed or uncrushed gravel, washed, ASTM D 448, Size 24, with 90 to 100 percent passing a 2-1/2-inch sieve and not more than 10 percent passing a 3/4-inch sieve.

B. Topsoil: Fertile, friable, surface soil, containing natural loam and complying University of Utah Topsoil Standards.

C. Filter Fabric: Manufacturer's standard, nonwoven, pervious, geotextile fabric of polypropylene, nylon, or polyester fibers.

Revise to a more substantial fence if required or add slats to enhance visibility. Less substantial temporary snow fencing is an alternative.

D. Chain Link Fence: Metallic-coated steel chain link fence fabric, 0.120-inch-diameter wire size; 48 inches high, minimum; line posts, 1.9 inches in diameter; terminal and corner posts, 2-3/8 inches in diameter; top rail, 1-5/8 inches in diameter; bottom tension wire, 0.177 inch in diameter; with tie wires, hog ring ties, and other accessories for a complete fence system.

E. Bark Mulch: Bark Mulch (Shredded bark, natural and non-dyed): Placed around trees as indicated on the Drawings placed to a depth of 6 inches.

If specifying other materials such as drainage materials, fertilizers, antidesiccants, and tree preservation signs, add here.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to the removal of any existing tree, the contractor to receive written approval from the owner, tagged on site, and be removed per University of Utah Standards.

B. An arborist shall be consulted during the duration of the project to ensure the means and measures are being used to protect the existing trees. Inspections by the arborist shall occur bi-weekly during the months of May to Sept. and monthly during the months from Oct. to April. A report shall be issued by the arborist after the inspection.

C. Temporary Fencing: Install temporary fencing located as indicated or outside the drip line of trees to protect remaining vegetation from construction damage. As indicated on the Drawings. Contractor to meet with the Landscape Architect and Arborist to define specific fencing locations for this project during phases of construction.

Revise fence installation requirements below if another fence system is specified.

1. Install chain link fence according to ASTM F 567 and manufacturer's written instructions.

D. Protect tree root systems from damage due to noxious materials caused by runoff or spillage while mixing, placing, or storing construction materials. Protect root systems from flooding, eroding, or excessive wetting caused by dewatering operations.

E. Do not store construction materials, debris, or excavated material within the drip line of remaining trees. Do not permit vehicles or foot traffic within the drip line; prevent soil compaction over root systems.

F. Do not allow fires under or adjacent to remaining trees or other plants.

G. Install 6 inches of temporary bark mulch around trees as indicated on the Drawings.

H. Any tree to be protected within the limit of work shall be protected shall fertilized in the spring and fall and provide soil conditioner and root pruning.

I. The location of the rigid fencing shall be indicated by paint by the landscape architect and University of Utah Grounds Maintenance representative prior to the installation of the fencing. the general contractor shall schedule request the marking for the location of the fencing one week prior to the installation of the rigid fencing. No fencing shall be moved unless the contractor receives approval from the University of Utah Grounds Maintenance.

3.2 EXCAVATION

Delete this Article when neither construction nor utility excavation near trees is required.

A. Install shoring or other protective support systems to minimize sloping or benching of excavations.

B. Do not excavate within drip line of trees, unless otherwise indicated and approved by Landscape Architect and/or Arborist.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks and comb soil to expose roots.

Procedure in subparagraph below may be expensive. Retain to limit damage to roots of valuable trees or delete if not required.

1. Relocate roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and relocate them without breaking. If encountered immediately adjacent to location of new construction and relocation is not practical, cut roots approximately 3 inches back from new construction.
2. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

Delete paragraph and subparagraph below if trenching is not required.

D. Where utility trenches are required within drip line of trees, tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.

3.3 RE-GRADING

Retain one of two paragraphs below.

A. Grade Lowering: Where new finish grade is indicated below existing grade around trees, slope grade beyond drip line of trees. Maintain existing grades within drip line of trees.

Retain paragraph and subparagraph below when existing grade is to be lowered within drip line of trees, or indicate requirements on Drawings.

B. Grade Lowering: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by qualified arborist, unless otherwise indicated.
1. Root Pruning: Prune tree roots exposed during grade lowering. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots with sharp pruning instruments; do not break or chop.

Retain applicable fill paragraphs below when raising grades around trees.

C. Minor Fill: Where existing grade is 6 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

Delete paragraph below if not required. Measures may provide adequate aeration if area is well drained. Coordinate description with details on Drawings or expand if more elaborate measures are necessary.

D. Moderate Fill: Where existing grade is more than 6 inches but less than 12 inches, below elevation of finish grade, place drainage fill, filter fabric, and topsoil on existing grade as follows:

1. Carefully place drainage fill against tree trunk approximately 2 inches above elevation of finish grade and extend not less than 18 inches from tree trunk on all sides. For balance of area within drip-line perimeter, place drainage fill up to 6 inches below elevation of grade.
2. Place filter fabric with edges overlapping 6 inches minimum.
3. Place fill layer of topsoil to finish grade. Do not compact drainage fill or topsoil. Hand grade to required finish elevations.

3.4 TREE PRUNING

A. Prune remaining trees affected by temporary and new construction.

B. Prune remaining trees to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by qualified arborist.

C. Pruning Standards: Prune trees according to ANSI A300 as follows:

Select one or more of six subparagraphs below. Distinguish individual trees or site zones requiring multiple types of pruning. Add detailed instructions for removing specific branches, or branches of a specific minimum or maximum diameter, if required. Augment below with arborist's report if an arborist is retained by Owner. See Evaluations for a discussion of pruning.

1. Type of Pruning: Crown cleaning.
2. Type of Pruning: Crown thinning.
3. Type of Pruning: Crown raising.
4. Type of Pruning: Crown reduction.
5. Type of Pruning: Vista pruning.
6. Type of Pruning: Crown restoration.

D. Cut branches with sharp pruning instruments; do not break or chop.

E. Chip branches removed from trees. Spread chips where indicated or as directed by the Landscape Architect.

3.5 TREE REPAIR AND REPLACEMENT

A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to written instructions of the qualified arborist.

B. Remove and replace dead and damaged trees that the qualified arborist determines to be incapable of restoring to a normal growth pattern.

Insert applicable requirements if Division 2 Section "Trees and Shrubs" is not included.

1. Provide new trees of the same size and species as those being replaced; plant and maintain as specified in Division 2 Section "Landscaping."

Subparagraph below is an alternative to subparagraph above since replacing large trees with trees of equal size is difficult and not always successful. Retain, delete, or revise to suit Project.

2. Provide new trees of 6-inch caliper size and of a species selected by Owner's Representative when trees more than 6 inches in caliper size, measured 12 inches above grade, are required to be replaced.

Delete below if aeration procedure is not acceptable. Aeration opens pathways for air and moisture to reach feeder roots choked by compacted soils. Revise hole diameter or frequency if required. Arborists are divided about benefits of this procedure.

C. Aerate surface soil, compacted during construction, 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch-diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augured soil and sand.

3.6 DISPOSAL OF WASTE MATERIALS

A. Burning is not permitted.

Revise below when disposal of some or all materials to designated site storage areas is permitted.

B. Disposal: Remove excess excavated material, displaced trees, and excess chips from Owner's property.

END OF SECTION

SECTION 015713 - TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

D. Performance bond.

E. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for temporary and permanent erosion control structures indicated on drawings.

B. Section 311000 - Site Clearing: Limits on clearing; disposition of vegetative clearing debris.

C. Section 312200 - Grading: Temporary and permanent grade changes for erosion control.

1.03 PERFORMANCE REQUIREMENTS

A. Develop and follow an Erosion and Sedimentation Prevention Plan and submit periodic inspection reports.

B. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.

C. Provide to Owner a Performance Bond covering erosion and sedimentation preventive measures only, in an amount equal to 100 percent of the cost of erosion and sedimentation control work.

D. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.

E. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.

1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.

F. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.

1. Control movement of sediment and soil from temporary stockpiles of soil.
2. Prevent development of ruts due to equipment and vehicular traffic.
3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

G. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.

1. Prevent windblown soil from leaving the project site.
2. Prevent tracking of mud onto public roads outside site.
3. Prevent mud and sediment from flowing onto sidewalks and pavements.
4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

H. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.

1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

I. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.

1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

J. Open Water: Prevent standing water that could become stagnant.

K. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

1.04 SUBMITTALS

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

B. Erosion and Sedimentation Control Plan:

1. Include:

a. Site plan identifying soils and vegetation, existing erosion problems, and areas vulnerable to erosion due to topography, soils, vegetation, or drainage.
b. Site plan showing grading; new improvements; temporary roads, traffic accesses, and other temporary construction; and proposed preventive measures.
c. Where extensive areas of soil will be disturbed, include storm water flow and volume calculations, soil loss predictions, and proposed preventive measures.
d. Schedule of temporary preventive measures, in relation to ground disturbing activities.
e. Other information required by law.
f. Format required by law is acceptable, provided any additional information specified is also included.

2. Obtain the approval of the Plan by authorities having jurisdiction.
3. Obtain the approval of the Plan by Owner.

C. Certificate: Mill certificate for silt fence fabric attesting that fabric and factory seams comply with specified requirements, signed by legally authorized official of manufacturer; indicate actual minimum average roll values; identify fabric by roll identification numbers.

D. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

PART 2 PRODUCTS

2.01 MATERIALS

A. Grass Seed For Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.

B. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:

1. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751.
2. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D4491/D4491M.
3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.
4. Tensile Strength: 100 pounds-force, minimum, in cross-machine direction; 124 pounds-force, minimum, in machine direction; when tested in accordance with ASTM D4632/D4632M.
5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632/D4632M.
6. Tear Strength: 55 pounds-force, minimum, when tested in accordance with ASTM D4533/D4533M.
7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.

C. Silt Fence Posts: One of the following, minimum 5 feet long:

1. Hardwood, 2 by 2 inches in cross section.

D. Concrete: See Section 033000.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.

B. Construction Entrances: Traffic-bearing aggregate surface.

1. Width: As required; 20 feet, minimum.
2. Length: 50 feet, minimum.
3. Provide at each construction entrance from public right-of-way.
4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.

C. Linear Sediment Barriers: Made of silt fences.

1. Provide linear sediment barriers:

    a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.

2. Space sediment barriers with the following maximum slope length upslope from barrier:

    a. Slope of Less Than 2 Percent: 100 feet..
    b. Slope Between 2 and 5 Percent: 75 feet.
    c. Slope Between 5 and 10 Percent: 50 feet.
    d. Slope Between 10 and 20 Percent: 25 feet.
    e. Slope Over 20 Percent: 15 feet.

D. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:

1. Filter fabric wrapped around hollow concrete blocks blocking entire inlet face area; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet.
2. Straw bale row blocking entire inlet face area; anchor into pavement.

E. Storm Drain Drop Inlet Sediment Traps: As detailed on drawings.

F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.

G. Soil Stockpiles: Protect using one of the following measures:

1. Cover with polyethylene film, secured by placing soil on outer edges.
2. Cover with mulch at least 4 inches thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 6 inches of straw or hay.

H. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.

I. Temporary Seeding: Use where temporary vegetated cover is required.

3.04 INSTALLATION

A. Traffic-Bearing Aggregate Surface:

1. Excavate minimum of 6 inches.
2. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.
3. Place and compact at least 6 inches of 1 1/2 to 3 1/2 inch diameter stone.

B. Silt Fences:

1. Store and handle fabric in accordance with ASTM D4873/D4873M.

2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.
3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch high barriers, minimum 48 inch long posts spaced at 6 feet maximum, with fabric embedded at least 6 inches in ground.
4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet, use nominal 32 inch high barriers with woven wire reinforcement and steel posts spaced at 4 feet maximum, with fabric embedded at least 6 inches in ground.
5. Install with top of fabric at nominal height and embedment as specified.
6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
7. Fasten fabric to wood posts using one of the following:

    a. Four nails per post with 3/4 inch diameter flat or button head, 1 inch long, and 14 gauge, 0.083 inch shank diameter.
    b. Five staples per post with at least 17 gauge, 0.0453 inch wire, 3/4 inch crown width and 1/2 inch long legs.

8. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.

C. Temporary Seeding:

1. When hydraulic seeder is used, seedbed preparation is not required.
2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft.
4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft.
5. Incorporate fertilizer into soil before seeding.
6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
8. Repeat irrigation as required until grass is established.

3.05 MAINTENANCE

A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.

B. Repair deficiencies immediately.

C. Silt Fences:

1. Promptly replace fabric that deteriorates unless need for fence has passed.
2. Remove silt deposits that exceed one-third of the height of the fence.
3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

D. Clean out temporary sediment control structures weekly and relocate soil on site.

E. Place sediment in appropriate locations on site; do not remove from site.

3.06 CLEAN UP

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION 015713

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SECTION 015719 - TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Construction procedures to promote adequate indoor air quality after construction.

B. Building flush-out after construction and before occupancy.

C. Testing indoor air quality before commencement of construction; existing building areas only.

D. Testing indoor air quality after completion of construction.

1.02 PROJECT GOALS

A. Dust and Airborne Particulates: Prevent deposition of dust and other particulates in HVAC ducts and equipment.

1. Cleaning of ductwork is not contemplated under this Contract.
2. Contractor shall bear the cost of cleaning required due to failure to protect ducts and equipment from construction dust.
3. Establish condition of existing ducts and equipment prior to start of alterations.

B. Airborne Contaminants: Procedures and products have been specified to minimize indoor air pollutants.

1. Furnish products meeting the specifications.
2. Avoid construction practices that could result in contamination of installed products leading to indoor air pollution.

C. Environmental Tobacco Smoke Control: Smoking rooms have been designed with direct exhaust to outdoors, no recirculated air, impermeable partitions from floor to structure above, and negative pressure of at least 0.03 inch wg.

D. Smoking and Controlled Substance Restrictions: Use of tobacco products, vaping products, alcoholic beverages, and other controlled substances on Project site is **NOT PERMITTED.**

1.03 DEFINITIONS

A. Adsorptive Materials: Gypsum board, acoustical ceiling tile and panels, carpet and carpet tile, fabrics, fibrous insulation, and other similar products.

B. Contaminants: Gases, vapors, regulated pollutants, airborne mold and mildew, and the like, as specified.

C. Particulates: Dust, dirt, and other airborne solid matter.

D. Wet Work: Concrete, plaster, coatings, and other products that emit water vapor or volatile organic compounds during installation, drying, or curing.

1.04 SUBMITTALS

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

B. Indoor Air Quality Management Plan: Describe, in detail, measures to be taken to promote adequate indoor air quality upon completion; use SMACNA (OCC) as a guide.

1. Submit not less than 60 days before enclosure of building.
2. Identify potential sources of odor and dust.
3. Identify construction activities likely to produce odor or dust.
4. Identify areas of project potentially affected, especially occupied areas.
5. Evaluate potential problems by severity and describe methods of control.
6. Describe construction ventilation to be provided, including type and duration of ventilation, use of permanent HVAC systems, types of filters and schedule for replacement of filters.
7. Describe cleaning and dust control procedures.

C. Interior Finishes Installation Schedule: Identify each interior finish that either generates odors, moisture, or vapors or is susceptible to adsorption of odors and vapors, and indicate air handling zone, sequence of application, and curing times.

D. Duct and Terminal Unit Inspection Report.

E. Air Contaminant Test Plan: Identify:

1. Testing agency qualifications.
2. Locations and scheduling of air sampling.
3. Test procedures, in detail.
4. Test instruments and apparatus.
5. Sampling methods.

F. Air Contaminant Test Reports: Show:

1. Location where each sample was taken, and time.
2. Test values for each air sample; average the values of each set of 3.
3. HVAC operating conditions.
4. Certification of test equipment calibration.
5. Other conditions or discrepancies that might have influenced results.

G. Ventilation Effectiveness Test Plan: Identify:

1. Testing agency qualifications.
2. Description of test spaces, including locations of air sampling.
3. Test procedures, in detail; state whether tracer gas decay or step-up will be used.
4. Test instruments and apparatus; identify tracer gas to be used.
5. Sampling methods.

H. Ventilation Effectiveness Test Reports: Show:

1. Preliminary tests of instruments and apparatus and of test spaces.

2. Calculations of ventilation effectiveness, variable "E".
3. Location where each sample was taken, and time.
4. Test values for each air sample.
5. HVAC operating conditions.
6. Other information specified in ASHRAE Std 129.
7. Other conditions or discrepancies that might have influenced results.

I. Smoking Room Test and Inspection Plan: Identify:

1. Testing agency qualifications.
2. Description of test spaces, including locations of air sampling.
3. Test procedures, in detail.
4. Test instruments and apparatus; identify tracer gas to be used.
5. Sampling methods.

J. Smoking Room Test and Inspection Reports: Show:

1. Preliminary tests of instruments and apparatus.
2. Inspection of membrane seals in test spaces.
3. HVAC operating conditions.
4. Location where each sample was taken, and time.
5. Test values for each air sample.
6. Other information specified in ASHRAE Std 129.
7. Other conditions or discrepancies that might have influenced results.

1.05 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: Independent testing agency having minimum of 5 years experience in performing the types of testing specified.

PART 2 PRODUCTS

2.01 MATERIALS

A. Low VOC Materials: See other sections for specific requirements for materials with low VOC content.

B. Auxiliary Air Filters: MERV of 8, minimum, when tested in accordance with ASHRAE Std 52.2.

PART 3 EXECUTION

3.01 CONSTRUCTION PROCEDURES

A. Prevent the absorption of moisture and humidity by adsorptive materials by:

1. Sequencing the delivery of such materials so that they are not present in the building until wet work is completed and dry.
2. Delivery and storage of such materials in fully sealed moisture-impermeable packaging.
3. Provide sufficient ventilation for drying within reasonable time frame.

B. Begin construction ventilation when building is substantially enclosed.

C. When working in a portion of an occupied building, prevent movement of air from construction area to occupied area.

D. Do not store construction materials or waste in mechanical or electrical rooms.

E. Prior to use of return air ductwork without intake filters clean up and remove dust and debris generated by construction activities.

1. Inspect duct intakes, return air grilles, and terminal units for dust.
2. Clean plenum spaces, including top sides of lay-in ceilings, outsides of ducts, tops of pipes and conduit.
3. Clean tops of doors and frames.
4. Clean mechanical and electrical rooms, including tops of pipes, ducts, and conduit, equipment, and supports.
5. Clean return plenums of air handling units.
6. Remove intake filters last, after cleaning is complete.

F. Do not perform dusty or dirty work after starting use of return air ducts without intake filters.

G. Use other relevant recommendations of SMACNA (OCC) for avoiding unnecessary contamination due to construction procedures.

3.02 BUILDING FLUSH-OUT

A. Contractor's Option: Either full continuous flush-out OR satisfactory air contaminant testing is required, not both.

B. Perform building flush-out before occupancy.

C. Do not start flush-out until:

1. All construction is complete.
2. HVAC systems have been tested, adjusted, and balanced for proper operation.
3. Inspection of inside of return air ducts and terminal units confirms that cleaning is not necessary.
4. New HVAC filtration media have been installed.

D. Building Flush-Out: Operate all ventilation systems at normal flow rates with 100 percent outside air until a total air volume of 14,000 cubic feet per square foot of floor area has been supplied.

1. Obtain Owner's concurrence that construction is complete enough before beginning flush-out.
2. Maintain interior temperature of at least 60 degrees F and interior relative humidity no higher than 60 percent.
3. If additional construction involving materials that produce particulates or any of the specified contaminants is conducted during flush-out, start flush-out over.
4. If interior spaces must be occupied prior to completion of the flush-out, supply a minimum of 25 percent of the total air volume prior to occupancy, and:

    a. Begin ventilation at least three hours prior to daily occupancy.
    b. Continue ventilation during all occupied periods.
    c. Provide minimum outside air volume of 0.30 cfm per square foot or design minimum outside air rate, whichever is greater.

E. Install new HVAC filtration media after completion of flush-out and before occupancy or further testing.

3.03 AIR CONTAMINANT TESTING

A. Contractor's Option: Either full continuous flush-out, or satisfactory air contaminant testing is required, not both.

B. Perform air contaminant testing before starting construction, as base line for evaluation of post-construction testing.

C. Perform air contaminant testing before occupancy.

D. Do not start air contaminant testing until:

1. All construction is complete, including interior finishes.
2. HVAC systems have been tested, adjusted, and balanced for proper operation.
3. New HVAC filtration media have been installed.

E. Indoor Air Samples: Collect from spaces representative of occupied areas:

1. Collect samples while operable windows and exterior doors are closed, HVAC system is running normally as if occupied, with design minimum outdoor air, but with the building unoccupied.
2. Collect samples from spaces in each contiguous floor area in each air handler zone, but not less than one sample per 25,000 square feet; take samples from

areas having the least ventilation and those having the greatest presumed source strength.

3. Collect samples from height from 36 inches to 72 inches above floor.
4. Collect samples from same locations on 3 consecutive days during normal business hours; average the results of each set of 3 samples.
5. Exception: Areas with normal very high outside air ventilation rates, such as laboratories, do not need to be tested.
6. When retesting the same building areas, take samples from at least the same locations as in first test.

F. Outdoor Air Samples: Collect samples at outside air intake of each air handler at the same time as indoor samples are taken.

G. Analyze air samples and submit report.

H. Volatile Organic Compounds Limits:

1. Formaldehyde: Not more than 27 parts per billion.
2. Total Volatile Organic Compounds (TVOCs): Not more than 500 micrograms per cubic meter.
3. Chemicals Listed in CAL (CDPH SM) Table 4-1, other than Formaldehyde: Not more than allowable concentrations listed in Table 4-1.

I. Air Contaminant Concentration Test Methods:

1. Formaldehyde: ASTM D5197, EPA 625/R-96/010b Method TO-11A, or EPA 600/4-90/010 Method IP-6A.
2. Particulates: EPA 600/4-90/010 Method IP-10.
3. Total Volatile Organic Compounds (TVOC): EPA 625/R-96/010b Method TO-1, TO-15, or TO-17; or EPA 600/4-90/010 Method IP-1.
4. Chemicals Listed in CAL (CDPH SM) Table 4-1, except Formaldehyde: ASTM D5197, or EPA 625/R-96/010b Method TO-1, TO-15, or TO-17.
5. Carbon Monoxide: EPA 600/4-90/010 Method IP-3, plus measure outdoor air; measure in ppm; report both indoor and outdoor measurements.

END OF SECTION 015719

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General product requirements.

B. Sustainable design-related product requirements.

C. Transportation, handling, storage and protection.

D. Product option requirements.

E. Substitution limitations.

F. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

A. Section 012500 - Substitution Procedures: Substitutions made during procurement and/or construction phases.

B. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.

C. Section 017419 - Construction Waste Management and Disposal: Waste disposal requirements potentially affecting product selection, packaging and substitutions.

D. Section 018113.14 – Sustainable Design Requirements for DFCM HPBS.

1.03 SUBMITTALS

A. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

1. Submit within 15 days after date of Agreement.
2. For products specified only by reference standards, list applicable reference standards.

B. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC liquid floor treatments, curing and sealing compounds, materials, coatings and adhesives.

D. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

1.04 QUALITY ASSURANCE

A. Chain-of-Custody (COC): A procedure that tracks a product from the point of harvest or extraction to its end use, including successive stages of processing, transformation, manufacturing, and distribution.

B. Chain-of-Custody Certificates: Certificates signed by manufacturers and fabricators certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001.

C. Composite Wood and Agrifiber: Products made of wood particles and/or plant material pressed and bonded with adhesive or resin such as particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates, and door cores.

D. Corporate Sustainability Report: A third-party verified report that outlines the environmental impacts of extraction operations and activities associated with the manufacturer's product and the product's supply chain.

E. Cradle-to-Cradle Certified: End use product certified Cradle-to-Cradle v2 Basic or Cradle-to-Cradle v3 Bronze, minimum, as evidenced by C2C (DIR).

F. Environmental Product Declaration (EPD): Publicly available, critically reviewed life cycle analysis having at least a cradle-to-gate scope.

1. Good: Product-specific; compliant with ISO 14044.
2. Better: Industry-wide, generic; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
3. Best: Commercial-product-specific; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
4. Where demonstration of impact reduction below industry average is required, submit both industry-wide and commercial-product-specific declarations; or

submit at least 5 declarations for products of the same type by other manufacturers in the same industry.

G. Health Product Declarations (HPD): Complete, published declaration with full disclosure of known hazards, prepared using one of the HPDC (HPD-OLT) online tools.

H. Rapidly Renewable Materials: Made from agricultural products that are typically harvested within a 10-year or shorter cycle.

I. Recycled Content: Determine percentage of post-consumer and pre-consumer (post-industrial) content separately, using the guidelines contained in 16 CFR 260.13.

1. Previously used, reused, refurbished, and salvaged products are not considered recycled.
2. Wood fabricated from timber abandoned in transit to original mill is considered reused, not recycled.
3. Determine percentage of recycled content of any item by dividing the weight of recycled content in the item by the total weight of materials in the item.
4. Determine value of recycled content of each item separately, by multiplying the content percentage by the value of the item.
5. Acceptable Evidence:

    a. For percentage of recycled content, information from manufacturer.
    b. For cost, Contractor's cost data.

J. Source Location: Location of harvest, extraction, recovery, or manufacture; where information about source location is required to be submitted, give the postal address:

1. In every case, indicate the location of final assembly.
2. For harvested products, indicate location of harvest.
3. For extracted (i.e. mined) products, indicate location of extraction.
4. For recovered products, indicate location of recovery.
5. For products involving multiple manufacturing steps, provide a description of the process at each step, with location.
6. Acceptable Evidence:

    a. Manufacturer's certification.
    b. Life cycle analysis (LCA) performed by third-party.

K. Sustainably Harvested Wood: Solid wood, wood chips, and wood fiber certified or labeled by an organization accredited by one of the following:

1. The Forest Stewardship Council, The Principles for Natural Forest Management; for Canada visit http://www.fsccanada.org, for the USA visit http://www.fscus.org.
2. Acceptable Evidence: Copies of invoices bearing the certifying organization's certification numbers.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by Contract Documents.

B. Use of products having any of the following characteristics is not permitted:

C. Where other criteria are met, Contractor shall give preference to products that:

1. If used on interior, have lower emissions, as defined in Section 016116.
2. If wet-applied, have lower VOC content, as defined in Section 016116.
3. Have longer documented life span under normal use.
4. Result in less construction waste. See Section 017419
5. Are made of recycled materials.
6. Are Cradle-to-Cradle Certified.
7. Have a published Environmental Product Declaration (EPD).
8. Have a published Health Product Declaration (HPD).
9. Have a published Manufacturer's Inventory of Chemical Content.

2.02 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 MAINTENANCE MATERIALS

A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

A. See Section 012500 - Substitution Procedures.

3.02 TRANSPORTATION AND HANDLING

A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

D. Transport and handle products in accordance with manufacturer's instructions.

E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.

F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.03 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. See Section 017419.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

G. Comply with manufacturer's warranty conditions, if any.

H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

I. Prevent contact with material that may cause corrosion, discoloration, or staining.

J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 016000

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SECTION 016116 - VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for Indoor-Emissions-Restricted products.

B. Requirements for VOC-Content-Restricted products.

1.02 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Submittal procedures.

B. Section 018113 .14 – Sustainable Design Requirements – HPBS.

1.03 DEFINITIONS

A. Indoor-Emissions-Restricted Products: All products in the following product categories, whether specified or not:

B. VOC-Content-Restricted Products: All products in the following product categories, whether specified or not:

1. Interior paints and coatings applied on site.
2. Interior adhesives and sealants applied on site, including flooring adhesives.

C. Interior of Building: Anywhere inside the exterior weather barrier.

D. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.

E. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.

F. Inherently Non-Emitting Materials: Products composed wholly of minerals or metals, unless they include organic-based surface coatings, binders, or sealants; and specifically the following:

1. Concrete.
2. Clay brick.
3. Metals that are plated, anodized, or powder-coated.
4. Glass.
5. Ceramics.

6. Solid wood flooring that is unfinished and untreated.

1.04 SUBMITTALS

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

B. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance.

1.05 QUALITY ASSURANCE

A. VOC Content Test Method: 40 CFR 59, Subpart D (EPA Method 24), or ASTM D3960, unless otherwise indicated.

1. Evidence of Compliance: Acceptable types of evidence are:

a. Report of laboratory testing performed in accordance with requirements.
b. Published product data showing compliance with requirements.
c. Certification by manufacturer that product complies with requirements.

B. Composite Wood Emissions Standard: CARB (ATCM) for ultra-low emitting formaldehyde (ULEF) resins.

1. Evidence of Compliance: Acceptable types of evidence are:

a. Current SCS "No Added Formaldehyde (NAF)" certification; www.scscertified.com.
b. Report of laboratory testing performed in accordance with requirements.
c. Published product data showing compliance with requirements.

C. Furnishings Emissions Standard and Test Method: BIFMA e3 Sections 7.6.1 and 7.6.2, tested in accordance with BIFMA M7.1.

1. Evidence of Compliance:

a. Test report showing compliance and stating exposure scenario used.

D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS

2.01 MATERIALS

A. VOC-Content-Restricted Products: VOC content not greater than required by the following:

1. Adhesives, Including Flooring Adhesives: SCAQMD 1168 Rule.
2. Joint Sealants: SCAQMD 1168 Rule.
3. Paints and Coatings: Each color; most stringent of the following:

    a. 40 CFR 59, Subpart D.
    b. SCAQMD 1113 Rule.
    c. CARB (SCM).

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Owner reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to Owner.

B. Additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

END OF SECTION 016116

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SECTION 017000 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 017900 - Demonstration and Training: Demonstration of products and systems to be commissioned and where indicated in specific specification sections.

B. Section 018113 .14 – Sustainable Design Requirements – HPBS.

C. Section 078400 - Firestopping.

1.02 QUALIFICATIONS

A. For surveying work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate. Employ only individual(s) trained and experienced in collecting and recording accurate data relevant to ongoing construction activities,

1.03 PROJECT CONDITIONS

A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

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.

1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.

C. Mix Design: Submit proposed concrete mix design.

D. Samples: Submit samples of underslab vapor retarder to be used.

E. Test Reports: Submit report for each test or series of tests specified.

F. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.

G. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC liquid floor treatments, curing and sealing compounds, coatings, sealants and adhesives.

H. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 LAYING OUT THE WORK

A. Verify locations of survey control points prior to starting work.

B. Promptly notify Architect of any discrepancies discovered.

C. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

D. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

E. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.

F. Utilize recognized engineering survey practices.

G. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:

1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
2. Grid or axis for structures.
3. Building foundation, column locations, ground floor elevations.

H. Periodically verify layouts by same means.

I. Maintain a complete and accurate log of control and survey work as it progresses.

3.04 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.

C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.05 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. Perform whatever cutting and patching is necessary to:

1. Complete the work.
2. Fit products together to integrate with other work.
3. Provide openings for penetration of mechanical, electrical, and other services.
4. Match work that has been cut to adjacent work.
5. Repair areas adjacent to cuts to required condition.
6. Repair new work damaged by subsequent work.
7. Remove samples of installed work for testing when requested.
8. Remove and replace defective and non-complying work.

C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

D. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

F. Restore work with new products in accordance with requirements of Contract Documents.

G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 078400, to full thickness of the penetrated element.

I. Patching:

1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
2. Match color, texture, and appearance.
3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.06 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.07 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.08 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.

B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

F. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

G. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.09 DEMONSTRATION AND INSTRUCTION

A. See Section 017900 - Demonstration and Training.

3.10 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.11 FINAL CLEANING

A. Use cleaning materials that are nonhazardous.

B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.

D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

E. Clean filters of operating equipment.

F. Clean debris from roofs, overflow drains, area drains, and drainage systems.

G. Clean site; sweep paved areas, rake clean landscaped surfaces.

H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.12 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.

1. Provide copies to Architect and Owner.

B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.

C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.

D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.

E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.

F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.

G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.

H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.13 MAINTENANCE

A. Provide service and maintenance of components indicated in specification sections.

B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.

C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.

E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION 017000

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SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

1. At a minimum, recycle 75% of construction waste by weight or volume.

B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:

1. Aluminum and plastic beverage containers.
2. Corrugated cardboard.
3. Wood pallets.
4. Clean dimensional wood.
5. Land clearing debris, including brush, branches, logs, and stumps; see Section 311000 - Site Clearing for use options.
6. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.

E. Contractor Reporting Responsibilities: Submit periodic Waste Disposal Reports; report landfill disposal, incineration, recycling, salvage, and reuse regardless of to whom the cost or savings accrues; use the same units of measure on required reports.

F. Develop and follow a Waste Management Plan designed to implement these requirements. Provide Waste Stream Summary Report and Compliance Letter to DFCM with project Closeout.

G. The following sources may be useful in developing the Waste Management Plan:

H. Methods of trash/waste disposal that are not acceptable are:

1. Burning on the project site.
2. Burying on the project site.
3. Dumping or burying on other property, public or private.
4. Other illegal dumping or burying.

I. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 RELATED REQUIREMENTS

A. Section 012500 - Substitution Procedures.

B. Section 013000 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.

C. Section 015000 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.

D. Section 016000 - Product Requirements: Waste prevention requirements related to product substitutions.

E. Section 016000 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.

F. Section 017000 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

G. Section 018113.14 – Sustainable Design Requirements – HPBS.

H. Section 311000 - Site Clearing: Handling and disposal of land clearing debris.

1.03 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.04 SUBMITTALS

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

B. Sustainable Design Submittals: Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC liquid floor treatments, curing and sealing compounds, and adhesives.

C. Submit Waste Management Plan within 10 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner; submit projection of all trash and waste that will require disposal and alternatives to landfilling.

D. Waste Management Plan: Include the following information:

1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).

3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

E. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.

1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
2. Submit Report on a form acceptable to Owner.
3. Landfill Disposal: Include the following information:

    a. Identification of material.
    b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
    c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
    d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.

4. Incinerator Disposal: Include the following information:

    a. Identification of material.
    b. Amount, in tons or cubic yards, of trash/waste material from the project delivered to incinerators.
    c. State the identity of incinerators, total amount of fees paid to incinerator, and total disposal cost.
    d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.

5. Recycled and Salvaged Materials: Include the following information for each:

    a. Identification of material, including those retrieved by installer for use on other projects.
    b. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
    c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
    d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.

e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.

6. Material Reused on Project: Include the following information for each:

a. Identification of material and how it was used in the project.
b. Amount, in tons or cubic yards.
c. Include weight tickets as evidence of quantity.

7. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

PART 2 PRODUCTS

2.01 PRODUCT SUBSTITUTIONS

A. See Section 016000 and Section 012500.

B. For each proposed product substitution, submit the following information in addition to requirements specified in Section 016000:

1. Relative amount of waste produced, compared to specified product.
2. Cost savings on waste disposal, compared to specified product, to be deducted from the Contract Price.
3. Proposed disposal method for waste product.
4. Markets for recycled waste product.

PART 3 EXECUTION

3.01 WASTE MANAGEMENT PROCEDURES

A. See Section 013000 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. See Section 015000 for additional requirements related to trash/waste collection and removal facilities and services.

C. See Section 016000 for waste prevention requirements related to delivery, storage, and handling.

D. See Section 017000 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

3.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings.

1. Prebid meeting.
2. Preconstruction meeting.
3. Regular job-site meetings.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.

1. Provide containers as required.
2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION 017419

Construction Waste Management

Material	Recycler or Waste Hauler	Total Weight (tons)	% Diverted from Landfill

Weight Diverted	Has a waste ticket been provided?
0	
0	
0	
0	
0	
0	
0	
0	
0	
0	
0	
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SECTION 017800 - CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project record documents.

B. Operation and maintenance data.

C. Materials transparency manual.

D. Warranties and bonds.

1.02 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.

B. Section 017000 - Execution and Closeout Requirements: Contract closeout procedures.

C. Section 018113 .14 – Sustainable Design Requirements – HPBS.

D. Individual Product Sections: Specific requirements for operation and maintenance data.

E. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.

B. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC liquid floor treatments, curing and sealing compounds, coatings, sealants and adhesives.

C. Operation and Maintenance Data:

1. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.

2. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
3. Submit two sets of revised final documents in final form within 10 days after final inspection.

D. Materials Transparency Manual:

1. Compile and submit a digital and a printed version of information disclosing materials content for interior finishes, furnishings (including workstations), built-in furniture. Meet IWBI (BS) requirements for format and content.

E. Warranties and Bonds:

1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:

1. Manufacturer's name and product model and number.

2. Product substitutions or alternates utilized.
3. Changes made by Addenda and modifications.

F. Record Drawings: Legibly mark each item to record actual construction including:

1. Field changes of dimension and detail.
2. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

A. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

B. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

C. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

A. For Each Product, Applied Material, and Finish:

1. Product data, with catalog number, size, composition, and color and texture designations.
2. Information for re-ordering custom manufactured products.

B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.

C. Moisture protection and weather-exposed products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Additional information as specified in individual product specification sections.

E. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

A. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

B. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

C. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

D. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

1. Include HVAC outdoor and exhaust air damper calibration strategy.

a. Include provisions which ensure that full closure of dampers can be achieved.

2. Include Carbon Monoxide Monitoring Protocol.

E. Include manufacturer's printed operation and maintenance instructions.

F. Include sequence of operation by controls manufacturer.

G. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

H. Provide control diagrams by controls manufacturer as installed.

I. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.

J. Include test and balancing reports.

K. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.

B. Where systems involve more than one specification section, provide separate tabbed divider for each system.

C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.

D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.

F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.

G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.

H. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.

I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

J. Arrangement of Contents: Organize each volume in parts as follows:

1. Project Directory.
2. Table of Contents, of all volumes, and of this volume.
3. Operation and Maintenance Data: Arranged by system, then by product category.

    a. Source data.
    b. Operation and maintenance data.
    c. Field quality control data.
    d. Photocopies of warranties and bonds.

3.06 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

E. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.

F. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.

G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.

H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

END OF SECTION 017800

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

A. Demonstration of products and systems to be commissioned and where indicated in specific specification sections.

B. Training of Owner personnel in operation and maintenance is required for:

1. All software-operated systems.
2. HVAC systems and equipment.
3. Plumbing equipment.
4. Electrical systems and equipment.
5. Landscape irrigation.

C. Training of Owner personnel in care, cleaning, maintenance, and repair is required for:

1. Roofing, waterproofing, and other weather-exposed or moisture protection products.
2. Finishes, including flooring, wall finishes, ceiling finishes.
3. Fixtures and fittings.
4. Items specified in individual product Sections.

1.02 RELATED REQUIREMENTS

A. Section 017800 - Closeout Submittals: Operation and maintenance manuals.

B. Section 018113 .14 – Sustainable Design Requirements – HPBS.

C. Other Specification Sections: Additional requirements for demonstration and training.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures; except:

1. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority.
2. Submit one copy to the Commissioning Authority, not to be returned.
3. Make commissioning submittals on time schedule specified by Commissioning Authority.
4. Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of overall Training Plan; submit in editable electronic format, Microsoft Word 2003 preferred.

B. Draft Training Plans: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.

1. Submit to Commissioning Authority for review and inclusion in overall training plan.
2. Submit not less than four weeks prior to start of training.
3. Revise and resubmit until acceptable.
4. Provide an overall schedule showing all training sessions.
5. Include at least the following for each training session:

a. Identification, date, time, and duration.
b. Description of products and/or systems to be covered.
c. Name of firm and person conducting training; include qualifications.
d. Intended audience, such as job description.
e. Objectives of training and suggested methods of ensuring adequate training.
f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
g. Media to be used, such a slides, hand-outs, etc.
h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.

C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.

1. Include applicable portion of O&M manuals.
2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
3. Provide one extra copy of each training manual to be included with operation and maintenance data.

D. Training Reports:

1. Identification of each training session, date, time, and duration.
2. Sign-in sheet showing names and job titles of attendees.
3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.
4. Include Commissioning Authority's formal acceptance of training session.

1.04 QUALITY ASSURANCE

A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.

1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.

B. Demonstrations conducted during Functional Testing need not be repeated unless Owner personnel training is specified.

C. Demonstration may be combined with Owner personnel training if applicable.

D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.

1. Perform demonstrations not less than two weeks prior to Substantial Completion.
2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.

1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

A. Commissioning Authority will prepare the Training Plan based on draft plans submitted.

B. Conduct training on-site unless otherwise indicated.

C. Owner will provide classroom and seating at no cost to Contractor.

D. Do not start training until Functional Testing is complete, unless otherwise specified or approved by the Commissioning Authority.

E. Provide training in minimum two hour segments.

F. The Commissioning Authority is responsible for determining that the training was satisfactorily completed and will provide approval forms.

G. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.

H. Review of Facility Policy on Operation and Maintenance Data: During training discuss:

1. The location of the O&M manuals and procedures for use and preservation; backup copies.
2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
3. Typical uses of the O&M manuals.

I. Product- and System-Specific Training:

1. Review the applicable O&M manuals.
2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
4. Provide hands-on training on all operational modes possible and preventive maintenance.
5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
6. Discuss common troubleshooting problems and solutions.
7. Discuss any peculiarities of equipment installation or operation.
8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
9. Review recommended tools and spare parts inventory suggestions of manufacturers.
10. Review spare parts and tools required to be furnished by Contractor.
11. Review spare parts suppliers and sources and procurement procedures.

J. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION 017900

SECTION 018113.14 - SUSTAINABLE DESIGN REQUIREMENTS - HPBS

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 general requirements and procedures for compliance with DFCM High Performance Building System (HPBS), May 29, 2024.

1. Specific HPBS requirements are also included in other Sections.
2. Other HPBS requirements depend on product selections and may not be specifically identified as HPBS requirements. Compliance with requirements needed meet HPBS requirements may be used as one criterion to evaluate substitution requests and comparable product requests.
3. A copy of HPBS Project checklist, Appendix A, is attached at end of this Section for information only.

1.3 RELATED REQUIREMENTS

A. Section 016116 – Volitile Organic Compounds (VOC) Content Restrictions for limiting VOC's within the Building Enclosure.

B. Section 019115 – Building Enclosure Commissioning: Requirements for Building Enclosure Commissioning.

C. Section 019117 – Building Enclosure Functional Performance Testing Requirements: Requirements for Functional Building performance Testing.

D. General 019113 – Commissioning Requirements: Requirements for project Commissioning.

E. Section 220800 – Commissioning of Plumbing: Requirements related to project Plumbing Commissioning.

F. Section 230800 – Commissioning of HVAC: Requirements related to project Mechanical Commissioning.

G. Section 260800 – Commissioning of Electrical Systems: Requirements related to project Electrical Commissioning.

1.3 DEFINITIONS

A. BUG Rating: Classification system for luminaires defined in terms of backlight (B), uplight (U), and glare (G).

B. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001. Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.

C. Cradle-to-Gate Assessment: Analysis of a product's partial life-cycle from extraction (cradle) to gate (factory completion prior to distribution).

D. Life-Cycle Assessment: Evaluation of environmental impacts of a product from cradle to gate, defined by ISO 14040 and ISO 14044.

E. Life-Cycle Inventory: Database that defines environmental input and output for each step in a material or assembly's life cycle.

F. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

1. "Postconsumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
2. "Preconsumer" material is defined as material diverted from the waste stream during the manufacturing process. Reutilization of materials (such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it) is excluded.

G. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Review HPBS requirements and action plans for compliance with requirements.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Architect about HPBS requirements that are Contractor's responsibility, that depend on product selection or product qualities, or that depend on Contractor's procedures.

B. Submit documentation to DFCM that are Contractor's responsibility, that depend on product selection or product qualities, or that depend on Contractor's procedures.

1.6 ACTION SUBMITTALS

A. General: Submit HPBS submittals required by this and other Sections.

B. HPBS submittals are in addition to other submittals.

1. If submitted item is identical to that proposed to comply with other requirements, include additional copy with other submittal as a record of compliance with indicated HPBS requirements instead of separate sustainable design submittal. Mark additional copy "HPBS submittal."

C. HPBS Documentation Submittals:

1. Documentation for luminaires indicating BUG ratings, lumens emitted, and vertical illuminance values.
2. Product Data and certification for WaterSense-labeled water fixtures.
3. Product Data for plumbing fixtures indicating flush or flow rate.
4. Documentation complying with Section 019113 "General Commissioning Requirements," Section 019115 "Building Enclosure Commissioning Requirements," Section 220800 "Commissioning of Plumbing," Section 230800 "Commissioning of HVAC," and Section 260800 "Commissioning of Electrical Systems."
5. Environmental Product Declarations (EPDs) complying with HPBS requirements.
6. Documentation for products that comply with HPBS requirements for multi-attribute optimization.

    a. Include documentation for regional materials, indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material and costs of regional materials.
    b. Include documentation for any applicable third-party certifications.

7. Sustainability reports for products that comply with HPBS requirements for raw material and source extraction reporting.
8. Documentation for products that comply with HPBS requirements for leadership extraction practices. Include the following:

    a. Product Data and certification letter from product manufacturers, indicating participation in an extended producer responsibility program and statement of costs.
    b. Product Data and certification for bio-based materials, indicating that they comply with requirements. Include statement of costs.
    c. Product Data and chain-of-custody certificates for products containing certified wood. Include invoices.
    d. Receipts for salvaged and refurbished materials used for Project, indicating sources and costs.
    e. Product Data and certification letter from product manufacturers, indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. 35% of building materials, by value, shall meet the regional and/or recycled content threshold. Identify key materials that shall meet a regional or recycled material threshold.

f. Key materials include concrete, masonry, gypsum board, structural steel, steel joists, regionally manufactured miscellaneous metals, plastic containing materials, carpet and suspended ceiling systems.
g. Documentation for regional materials, indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material and costs of regional materials.
h. Contractor shall track regional and recycled content in construction materials using the DFCM HPBS Appendix G.

9. Material ingredient reports for products that comply with DFCM HPBS requirements for material ingredient reporting.
10. Documentation for products that comply with DFCM HPBS requirements for product manufacturer supply chain optimization.

    a. Include documentation for regional materials, indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material and costs of regional materials.

11. Documentation complying with Section 017419 "Construction Waste Management and Disposal."
12. Product Data for adhesives and sealants used inside weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials. All interior paints and coatings shall meet the low emitting materials standards set forth by State of Utah Administrative Rule R307-342, Adhesives and Sealants.
13. Product Data for paints and coatings used inside weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials. All interior paints and coatings shall meet the low emitting materials standards set forth by State of Utah Administrative Rule R307-361, Architectural Coatings.
14. Laboratory test reports for flooring, indicating compliance with requirements for low-emitting materials meeting Greenlabel Plus, FloorScore, Greenguard, or the Greenguard low emitting requirements, as applicable, based on flooring types.
15. Laboratory test reports for products containing composite wood or agrifiber products or wood glues, indicating compliance with requirements for low-emitting materials.
16. Laboratory test reports for ceilings, walls, and thermal insulation, indicating compliance with requirements for low-emitting materials.
17. Identify key materials that shall meet low emitting material standards within the project specifications.
18. Contractor to track VOC content and low-emitting testing standards using HPBS Tracking Spreadsheet and submit the completed spreadsheet and compliance letter to DFCM with project-close-out documentation.
19. Construction Indoor-Air-Quality (IAQ) Management:

    a. Contractor shall implement Construction IAQ management plan that meets SMACNA IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition, ANSI/SMACNA 008-2008 requirements.

    b. Implement a pre-occupancy air quality plan.
    c. Product Data for temporary filtration media.

d. Product Data for filtration media used during occupancy.
e. Construction Documentation: Six photographs at three different times during construction period, along with brief description of SMACNA approach employed, documenting implementation of IAQ management measures, including protection of ducts and on-site stored or installed absorptive materials.
f. At the end of construction, prior to occupancy, conduct a building flush-out or an air quality test per Section 019115 – Building Enclosure Commissioning Requirements.

20. Material Durability:

a. The project shall be designed to meet the Owner's expectations for building life span.

1) Exterior Building Cladding: 50+ years.
2) Aluminum window and door system: 25 years.
3) Membrane Roof: Minimum 20 years.
4) Mechanical Systems: 20 years.
5) Plumbing Systems: 30 years.
6) Electrical Accessories, Lighting and Controls: 10 – 30 years.
7) Materials with a useful lifespan of 10 years or less shall be 100% recyclable, at the end of their life. These materials shall include carpets, appliances and equipment, and furniture systems.
8) At the completion of construction, a list of building systems and anticipated life spans shall be submitted to DFCM with Project Closeout documents to be incorporated into the State Asset management software. Specific recycling instructions for materials with an anticipated life span of less than 10 years shall be provided in the Operations and Management documentation by the Contractor.
9) Deliverables: HPBS Project Checklist (Appendix A) and associated required submission information, Appendix G.

21. Hazardous Waste Managemen6t Plan:

a. Minimize hazardous waste on-site. Conduct an assessment of cleaning materials, maintenance materials and any chemicals used within the building to determine opportunities to replace hazardous materials with water-based or less hazardous materials. If hazardous materials shall continue to be used within a building, a hazardous material storage plan shall be created to safely house hazardous materials before use, as well as after use, prior to pick up.
b. Green Cleaning program: All cleaning materials must comply with the Utah Administrative Rule R307-304. Solvent Cleaning.

22. IAQ Assessment:

a. Signed statement describing the building air flush-out procedures, including dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
b. Product Data for filtration media used during flush-out and occupancy.

c. Report from testing and inspecting agency indicating results of IAQ testing and documentation that show compliance with IAQ testing procedures and requirements.

23. Energy Compliance: All applicable appliances, equipment, products, and or furnishings shall meet one or more of the following criteria:

    a. ENERGY STAR Qualified.
    b. EPACT Registered.
    c. Products that meet or exceed the US Department of Energy's FEMP Energy Efficiency Recommendations.
    d. Utility company incentive/rebate approved equipment (various sources).

24. Environmental Controls: Include Environmental Controls for:
    a. Lighting Controls for all conference rooms, classrooms, meeting rooms, and other group spaces for more than 10 people.
    b. Thermal Comfort: Provide a minimum of one thermostat in all conference rooms, classrooms, and meeting rooms that have a capacity for more than 10 people.
    c. Internal Shades: Provide internal roller shades for all exterior windows of regularly occupied spaces.
    d. Lighting Quality: Use LED lamps with a CRI of 80 or greater within all regularly occupied spaces.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Contractor's Sustainability Manager.

B. Sustainable Design Action Plans: Provide preliminary submittals within **30 days** of date established for **the Notice to Proceed**, indicating how the following requirements will be met:

1. List of proposed products with EPDs.
2. List of proposed products complying with requirements for raw material and source extraction reporting.
3. List of proposed products complying with requirements for material ingredient reporting.
4. Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
5. Construction IAQ management plan.

C. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with sustainable design action plans.

1.8 QUALITY ASSURANCE

A. Sustainability Project Manager: Engage an experienced Sustainable Design DFCM HPBS project manager to coordinate HPBS requirements. Sustainability Consultant may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide products and procedures necessary to comply with DFCM HPBS requirements indicated as Contractor's responsibility. Other Sections may specify some requirements that contribute to the HPBS requirements indicated.

B. At least 35% of building materials, by value, shall meet the regional and/or recycled content thresholds.

C. Recycled Content: Building materials shall have recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content. Only 50% of the value of the pre-consumer recycled content shall contribute toward the sustainable value of the product. Only the value associated with the recycled content shall contribute to the sustainable value of the product.

1. Cost of postconsumer recycled content plus one-half of preconsumer recycled content of an item shall be determined by dividing weight of postconsumer recycled content plus one-half of preconsumer recycled content in the item by total weight of the item and multiplying by cost of the item.
2. Do not include furniture, plumbing, mechanical and electrical components, and specialty items, such as elevators and equipment, in the calculation.

2.2 LOW-EMITTING MATERIALS

A. Paints and Coatings: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits unless otherwise indicated:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Clear Wood Finishes, Varnishes: 275 g/L.
9. Clear Wood Finishes, Lacquers: 275 g/L.
10. Floor Coatings: 50 g/L.
11. Shellacs, Clear: 730 g/L.
12. Shellacs, Pigmented: 550 g/L.
13. Stains: 100 g/L.

B. Paints and Coatings: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with requirements of California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Adhesives and Sealants: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits, unless otherwise indicated:

1. Wood Glues: 30 g/L.
2. Metal-to-Metal Adhesives: 30 g/L.
3. Adhesives for Porous Materials (except Wood): 50 g/L.
4. Subfloor Adhesives: 50 g/L.
5. Plastic Foam Adhesives: 50 g/L.
6. Carpet Adhesives: 50 g/L.
7. Carpet Pad Adhesives: 50 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesives: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesives: 100 g/L.
18. Structural Wood Member Adhesives: 140 g/L.
19. Single-Ply Roof Membrane Adhesives: 250 g/L.
20. Special-Purpose Contact Adhesives (That Are Used to Bond Melamine-Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch (1.6 mm) or Less in Thickness to Any Surface): 250 g/L.
21. Top and Trim Adhesives: 250 g/L.
22. Plastic Cement Welding Compounds: 250 g/L.
23. ABS Welding Compounds: 325 g/L.
24. CPVC Welding Compounds: 490 g/L.
25. PVC Welding Compounds: 510 g/L.
26. Adhesive Primer for Plastic: 550 g/L.
27. Sheet-Applied Rubber Lining Adhesives: 850 g/L.
28. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
29. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
30. Special-Purpose Aerosol Adhesives (All Types): 70 percent by weight.
31. Other Adhesives: 250 g/L.
32. Architectural Sealants: 250 g/L.
33. Nonmembrane Roof Sealants: 300 g/L.
34. Single-Ply Roof Membrane Sealants: 450 g/L.
35. Other Sealants: 420 g/L.
36. Sealant Primers for Nonporous Substrates: 250 g/L.
37. Sealant Primers for Porous Substrates: 775 g/L.
38. Modified Bituminous Sealant Primers: 500 g/L.
39. Other Sealant Primers: 750 g/L.

D. Adhesives and Sealants: For field applications that are inside the weatherproofing system, 90 percent of adhesives and sealants shall comply with requirements of California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Flooring: Shall comply with requirements of California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Composite Wood, Agrifiber Products, and Adhesives: Shall be made using ultra-low-emitting formaldehyde resins as defined in California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

G. Ceilings, Walls, and Thermal Insulation: Shall comply with requirements of California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 NONSMOKING BUILDING

A. Smoking is not permitted within the building or within 25 ft. (8 m) of entrances, operable windows, or outdoor-air intakes.

3.2 CONSTRUCTION WASTE MANAGEMENT

A. Comply with Section 017419 "Construction Waste Management and Disposal."

3.3 CONSTRUCTION INDOOR-AIR-QUALITY (IAQ) MANAGEMENT

A. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."

1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 015000 "Temporary Facilities and Controls," install MERV 8 filter media at each return-air inlet for the air-handling system used during construction.
2. Replace air filters immediately prior to occupancy with new filters specified in Section 234100 "Particulate Air Filtration."

3.4 INDOOR-AIR-QUALITY (IAQ) ASSESSMENT

A. Flush-Out:

1. Refer to Section 019115 – Building Enclosure Commissioning Requirements.

B. Air-Quality Testing: Owner will engage testing agency to perform the following, unless otherwise indicated:

1. Refer to Section 019115 – Building Enclosure Commissioning Requirements.

DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

END OF SECTION 018113.14

	Programming	Schematic Design	Design Development	Construction Documents	Construction Administration	Pre-Occupancy	Post-Occupancy	1-Year Walkthrough
Integrated Design								
Submit High Performance Workshop Minutes	☑	☑						
Submit Owner's Project Requirements	☑	☑	☑	☑				
Submit User Manual						☐		
Community-Oriented Design								
OPR - Planning Document Review Summary	☑	☑						
BOD - Community Orientated Design		☑	☑	☑				
Pedestrian Pathways Identified on Site Plan	☑	☑	☑	☑				
Transportation Management								
DFCM Baseline Parking Quantities Identified	☑							
OPR - Alternative Transportation Management Expectations	☑	☑						
BOD - Alternative Transportation Management Stragegy		☑	☑	☑				
Bicycle Racks Identified on Site Plan			☑	☑				
Transportation Management Strategies Implemented							☐	
Site Design								
OPR - Building Location and Orientation	☑							
Acess Paths Identified on Site Plan		☑	☑	☑				
OPR - Stormwater Management Expectations			☑	☑				
BOD - Stormwater Management Strategy		☑						
Stormwater Management System Identified on Site Plan			☑	☑				
Specify and Install Appropriate Systems				☑	☐			
OPR - Heat Island Reduction	☑	☑	☑	☑				
BOD - Heat Island Reduction Plan		☑	☑	☑				
Appropriate Materials Identified on Site Plan			☑	☑				
Specify and Install Appropriate Materials				☑	☐			
OPR - Light Pollution Reduction	☑	☑						
BOD - Light Pollution Reduction Strategy		☑	☑	☑				
Appropriate Fixtures Identified on Site Lighting Plan				☑	☐			
Specify and Install Appropriate Fixtures				☑	☐			
Building Performance								
Energy Modeling								
OPR - Energy Performance Expectations - EUI Target	☑							
Energy Model - Actual EUI		☑	☑					
Life-Cycle Cost Analysis		☑	☑					
Commissioning - Energy Verification Period							☐	☐
Water Use Reduction								
OPR - Landscape Water Use Expectations	☑	☑						
WaterSense Water Budget	☑	☑						
BOD - Landscape Water Approach		☑	☑	☑				
Landscape Maintenance Schedule						☐		
OPR - Building Water Use Expectations	☑	☑						
BOD - Building and Process Water Use Strategy		☑	☑	☑				
Specify and Install Water Sense Certified Fixtures				☑	☐			

	Programming	Schematic Design	Design Development	Construction Documents	Construction Administration	Pre-Occupancy	Post-Occupancy	1-Year Walkthrough
Building Envelope Performance / Commissioning								
OPR -Building Envelope Performance Expectations	☑	☑						
BOD - Building Envelope Performance Strategy		☑	☑	☑				
Design Coordination Meeting		☑	☑	☑				
Building Envelope Commissioning Plan				☑				
Design Review			☑	☑				
Specify Functional Performance and Testing Requirements				☑				
Building Envelope Pre Construction and Construction Meetings					☐			
Mock Up Coordination and Testing					☐			
Observations and Testing					☐			
Whole Building Air Leakage Testing						☐		
Building Enclosure Maintenance Manual						☐		
Building System Performance / Commissioning								
OPR -Building System Performance Expectations	☑	☑						
BOD - Building System Performance Strategy	☑	☑	☑	☑				
Design Coordination Meeting			☑	☑				
Building System Commissioning Plan				☑				
Design Review			☑	☑				
Utility Incentive Coordination			☑	☑		☐		
Specify Functional Performance and Testing Requirements				☑				
Building System Pre Construction and Construction Meetings					☐			
Observations and Testing					☐			
Building System Training					☐	☐		
Building System Maintenance Manual						☐		
Warranty Phase Commissioning / Energy Performance Verification							☐	☐
BAS Tagging and Metering								
OPR - Metering Expectations	☑	☑						
BOD - Metering Strategy	☑	☑	☑	☑				
Meters designed, installed and commisioned				☑		☐		
Fault Detection						☐		
Data Point and Tagging					☐			
Building Performance Monitoring								
See Appendix D								
Energy Star Purchasing								
OPR - Energy Efficient Equipment Purchasing Expectations	☑	☑						
BOD - Energy Efficient Equipment Purchasing Standard		☑	☑	☑				
Purchase Energy Efficient Equipment						☐		
Material Impact Reduction								
OPR - Sustanable Material Requirements	☑	☑						
BOD - Sustainable Material Strategy		☑	☑	☑				
Specify and Install Appropriate Materials				☑	☐			
Locate water Bottle Filling Stations on Plans				☑				
Submit Construction Waste Management Plan					☐			
BOD - Post-Occupancy Recycling Strategy		☑	☑	☑				

	Programming	Schematic Design	Design Development	Construction Documents	Construction Administration	Pre-Occupancy	Post-Occupancy	1-Year Walkthrough
OPR - Durable Material Requirements	☑	☑						
BOD - Material Durability Strategy		☑	☑	☑				
Locate Recycling Areas on Floor Plans				☑				
Track Regional and Recycled Content					☐			
Provide Material Compliance Letter to DFCM						☐		
Occupant Wellness								
OPR - Indoor Air Quality Requirements	☑	☑						
BOD - Indoor Air Quality Design Strategy		☑	☑	☑				
BOD - Operations Indoor Air Quality Management Strategy		☑	☑	☑		☐		
Submit Construction Indoor Air Quality Management Plan					☐			
Track VOC Content and Low-Emitting Test Standards					☐			
Provide Material Compliance Letter to DFCM						☐		
OPR - Hazardous Material Management Requirements	☑	☑						
BOD - Hazardous Material Management Strategy		☑	☑	☑				
OPR - Daylight and View Requirements	☑	☑						
BOD - Daylight and View Strategy		☑	☑	☑				
Daylight and View Plan				☑				
OPR - Environmental Control Requirements	☑	☑						
BOD - Environmental Control Strategy		☑	☑	☑				
OPR - Health and Productivity Requirements	☑	☑						
BOD - Health and Productivity Strategy		☑	☑	☑				
Education and Outreach								
Specify User Education and Outreach Requirements				☑		☐		
Submit Sustainability Signage						☐		
Specify Facility Management Traning Requirements				☑				
Facilities Management Training					☐	☐	☐	
Submit Installation and Training Video(s)						☐		
Submit User Manual						☐		

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

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.

B. Owner's Project Requirements and Basis-of-Design Document are included by reference for information only.

1.2 SUMMARY

A. Section Includes:

1. General requirements for coordinating and scheduling commissioning activities.
2. Commissioning meetings.
3. Commissioning reports.
4. Use of commissioning process test equipment, instrumentation, and tools.
5. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
6. Commissioning tests and commissioning test demonstration.
7. Adjusting, verifying, and documenting identified systems and assemblies.

B. Related Requirements:

1. Section 220800 "Commissioning of Plumbing" for technical commissioning requirements for plumbing.
2. Section 230800 "Commissioning of HVAC" for technical commissioning requirements for HVAC.
3. Section 260800 "Commissioning of Electrical Systems" for technical commissioning requirements for electrical systems.

1.3 DEFINITIONS

A. Acceptance Criteria: Threshold of acceptable work quality or performance specified for a commissioning activity, including, but not limited to, construction checklists, performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.

B. Basis-of-Design Document: A document prepared by Architect that records concepts, calculations, decisions, and product selections used to comply with Owner's Project Requirements and to suit applicable regulatory requirements, standards, and guidelines.

C. Commissioning Authority: An entity engaged by Owner, and identified in Section 011000 "Summary," to evaluate Commissioning-Process Work.

D. Commissioning Plan: A document, prepared by Commissioning Authority, that outlines the organization, schedule, allocation of resources, and documentation of commissioning requirements.

E. Commissioning: A quality-focused process for verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, and tested to comply with Owner's Project Requirements. The requirements specified here are limited to the construction phase commissioning activities.

F. Construction-Phase Commissioning-Process Completion: The stage of completion and acceptance of commissioning process when resolution of deficient conditions and issues discovered during commissioning process and retesting until acceptable results are obtained has been accomplished. Owner will establish in writing the date construction-phase commissioning-process completion is achieved. See Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.

1. Commissioning process is complete when the Work specified of this Section and related Sections has been completed and accepted, including, but not limited to, the following:

    a. Completion of tests and acceptance of test results.
    b. Resolution of issues, as verified by retests performed and documented with acceptance of retest results.
    c. Comply with requirements in Section 017900 "Demonstration and Training."
    d. Completion and acceptance of submittals and reports.

G. Owner's Project Requirements: A document that details the functional requirements of a project and the expectations of how it will be used and operated, including Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This document is prepared either by the Owner or for the Owner by the Architect or Commissioning Authority.

H. Owner's Witness: Commissioning Authority, Owner's Project Manager, or Architect-designated witness authorized to authenticate test demonstration data and to sign completed test data forms.

I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

J. Test: Performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.

K. Sampling Procedures and Tables for Inspection by Attributes: As defined in ASQ Z1.4.

1.4 COMPENSATION

A. If Architect, Commissioning Authority, other Owner's witness, or Owner's staff perform additional services or incur additional expenses due to actions of Contractor listed below, compensate Owner for such additional services and expenses.

1. Failure to provide timely notice of commissioning activities schedule changes.
2. Failure to meet acceptance criteria for test demonstrations.

1.5 COMMISSIONING TEAM

A. Members Appointed by Contractor(s):

1. Commissioning Coordinator: A person or entity employed by Contractor to manage, schedule, and coordinate commissioning process.
2. Project superintendent and other employees that Contractor may deem appropriate for a particular portion of the commissioning process.
3. Subcontractors, installers, suppliers, and specialists that Contractor may deem appropriate for a particular portion of the commissioning process.
4. Appointed team members shall have the authority to act on behalf of the entity they represent.

B. Members Appointed by Owner:

1. Commissioning Authority, plus consultants that Commissioning Authority may deem appropriate for a particular portion of the commissioning process.
2. Owner representative(s), facility operations and maintenance personnel, plus other employees, separate contractors, and consultants that Owner may deem appropriate for a particular portion of the commissioning process.
3. Architect, plus employees and consultants that Architect may deem appropriate for a particular portion of the commissioning process.

1.6 INFORMATIONAL SUBMITTALS

A. Comply with requirements in Section 013300 "Submittal Procedures" for submittal procedure general requirements for commissioning process.

B. Commissioning Plan Information:

1. List of Contractor-appointed commissioning team members to include specific personnel and subcontractors performing the various commissioning requirements.
2. Schedule of commissioning activities, integrated with the Construction Schedule. Comply with requirements in Section 013200 "Construction Progress Documentation" for the Construction Schedule general requirements for commissioning process.
3. Contractor personnel and subcontractors participating in each test.
4. List of instrumentation required for each test to include identification of parties that will provide instrumentation for each test.

C. Commissioning schedule.

D. Two-week look-ahead schedules.

E. Commissioning Coordinator Letter of Authority:

1. Within 10 days after approval of Commissioning Coordinator qualifications, submit a letter of authority for Commissioning Coordinator, signed by a principal of Contractor's firm. Letter shall authorize Commissioning Coordinator to do the following:

    a. Make inspections required for commissioning process.
    b. Coordinate, schedule, and manage commissioning process of Contractor, subcontractors, and suppliers.
    c. Obtain documentation required for commissioning process from Contractor, subcontractors, and suppliers.
    d. Report issues, delayed resolution of issues, schedule conflicts, and lack of cooperation or expertise on the part of members of the commissioning team.

F. Commissioning Coordinator Qualification Data: For entity coordinating Contractor's commissioning activities to demonstrate their capabilities and experience.

1. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

G. List test instrumentation, equipment, and monitoring devices. Include the following information:

1. Make, model, serial number, and application for each instrument, equipment, and monitoring device.
2. Brief description of intended use.
3. Calibration record showing the following:

    a. Calibration agency, including name and contact information.
    b. Last date of calibration.
    c. Range of values for which calibration is valid.
    d. Certification of accuracy.
    e. Certification for calibration equipment traceable to NIST.
    f. Due date of the next calibration.

H. Test Reports:

1. Pre-Startup Report: Prior to startup of equipment or a system, submit signed, completed construction checklists.
2. Test Data Reports: At the end of each day in which tests are conducted, submit test data for tests performed.
3. Commissioning Issue Reports: Daily, at the end of each day in which tests are conducted, submit commissioning issue reports for tests for which acceptable results were not achieved.
4. Weekly Progress Report: Weekly, at the end of each week in which tests are conducted, submit a progress report.

5. Data Trend Logs: Submit data trend logs at the end of the trend log period.
6. System Alarm Logs: Daily, at the start of days following a day in which tests were performed, submit printout of log of alarms that occurred since the last log was printed.

I. Construction Checklists:

1. Material checks.
2. Installation checks.
3. Startup procedures, where required.

1.7 CLOSEOUT SUBMITTALS

A. Commissioning Report:

1. At Construction-Phase Commissioning Completion, include the following:

a. Pre-startup reports.
b. Approved test procedures.
c. Test data forms, completed and signed.
d. Progress reports.
e. Commissioning issue report log.
f. Commissioning issue reports showing resolution of issues.
g. Correspondence or other documents related to resolution of issues.
h. Other reports required by commissioning process.
i. List unresolved issues and reasons they remain unresolved and should be exempted from the requirements for Construction-Phase Commissioning Completion.
j. Report shall include commissioning work of Contractor.

B. Request for Certificate of Construction-Phase Commissioning Process Completion.

C. Operation and Maintenance Data: For proprietary test equipment, instrumentation, and tools to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Commissioning Coordinator Qualifications:

1. Documented experience commissioning systems of similar complexity to those contained in these documents on at least three projects of similar scope and complexity.
2. Certification of commissioning-process expertise. The following certifications are acceptable. Owner reserves the right to accept or reject certifications as evidence of qualification.

a. Certified Commissioning Authority, by AABC Commissioning Group (ACG).
b. Commissioning-Process Management Professional, by American Society of Heating, Refrigerating and Air-Conditioning Engineers.
c. Certified Commissioning Professional, by Building Commissioning Association.

d. Accredited Commissioning-Process Authority Professional, by University of Wisconsin.
e. Accredited Commissioning-Process Manager, by University of Wisconsin.
f. Accredited Green Commissioning-Process Provider, by University of Wisconsin.

B. Calibration Agency Qualifications: Certified by The American Association for Laboratory Accreditation that the calibration agency complies with minimum requirements of ISO/IEC 17025.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

A. Test equipment and instrumentation required to perform the commissioning process shall remain the property of Contractor unless otherwise indicated.

B. Test equipment and instrumentation required to perform commissioning process shall comply with the following criteria:

1. Be manufactured for the purpose of testing and measuring tests for which they are being used and have an accuracy to test and measure system performance within the tolerances required to determine acceptable performance.
2. Calibrated and certified.

a. Calibration performed and documented by a qualified calibration agency according to national standards applicable to the tools and instrumentation being calibrated. Calibration shall be current according to national standards or within test equipment and instrumentation manufacturer's recommended intervals, whichever is more frequent, but not less than within six months of initial use on Project. Calibration tags shall be permanently affixed.
b. Repair and recalibrate test equipment and instrumentation if dismantled, dropped, or damaged since last calibrated.

3. Maintain test equipment and instrumentation.
4. Use test equipment and instrumentation only for testing or monitoring Work for which they are designed.

2.2 PROPRIETARY TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

A. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate, or perform work on its equipment.

1. Identify proprietary test equipment, instrumentation, and tools required in the test equipment identification list submittal.

2. Proprietary test equipment, instrumentation, and tools shall become the property of Owner at Substantial Completion.

2.3 REPORT FORMAT AND ORGANIZATION

A. General Format and Organization:
   1. Record report on compact disk.
   2. Electronic Data: Portable document format (PDF); a single file with outline-organized bookmarks for major and minor tabs and tab contents itemized for specific reports.

B. Commissioning Report:

   1. Include a table of contents and an index to each test.
   2. Include major tabs for each Specification Section.
   3. Include minor tabs for each test.
   4. Within each minor tab, include the following:

      a. Test specification.
      b. Pre-startup reports.
      c. Approved test procedures.
      d. Test data forms, completed and signed.
      e. Commissioning issue reports, showing resolution of issues, and documentation related to resolution of issues pertaining to a single test. Group data forms, commissioning issue reports showing resolution of issues, and documentation related to resolution of issues for each test repetition together within the minor tab, in reverse chronological order (most recent on top).

PART 3 - EXECUTION

3.1 PREPARATION

A. Review preliminary construction checklists and preliminary test procedures and data forms.

3.2 CONSTRUCTION CHECKLISTS

A. Construction checklists cannot modify or conflict with the Contract Documents.

B. Create construction checklists based on actual systems and equipment to be included in Project.

C. Material Checks: Compare specified characteristics and approved submittals with materials as received. Include factory tests and other evaluations, adjustments, and tests performed prior to shipment if applicable.

1. Service connection requirements, including configuration, size, location, and other pertinent characteristics.
2. Included optional features.
3. Delivery Receipt Check: Inspect and record physical condition of materials and equipment on delivery to Project site, including agreement with approved submittals, cleanliness, and lack of damage.
4. Installation Checks:

    a. Location according to Drawings and approved Shop Drawings.
    b. Configuration.
    c. Compliance with manufacturers' written installation instructions.
    d. Attachment to structure.
    e. Access clearance to allow for maintenance, service, repair, removal, and replacement without the need to disassemble or remove other equipment or building elements. Access coordinated with other building elements and equipment, including, but not limited to, ceiling and wall access panels, in a manner consistent with OSHA fall-protection regulations and safe work practices.
    f. Utility connections are of the correct characteristics, as applicable.
    g. Correct labeling and identification.
    h. Startup Checks: Verify readiness of equipment to be energized. Include manufacturer's standard startup procedures and forms.

D. Startup: Perform and document initial operation of equipment to prove that it is installed properly and operates as intended according to manufacturer's standard startup procedures, at minimum.

E. Performance Tests:

1. Static Tests: As specified elsewhere, including, but not limited to, duct and pipe leakage tests, insulation-resistance tests, and water-penetration tests.
2. Component Performance Tests: Tests evaluate the performance of an input or output of components under a full range of operating conditions.
3. Equipment and Assembly Performance Tests: Test and evaluate performance of equipment and assemblies under a full range of operating conditions and loads.
4. System Performance Tests: Test and evaluate performance of systems under a full range of operating conditions and loads.
5. Intersystem Performance Tests: Test and evaluate the interface of different systems under a full range of operating conditions and loads.

F. Deferred Construction Checklists: Obtain Owner approval of proposed deferral of construction checklists, including proposed schedule of completion of each deferred construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, deferred construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:

1. Identify deferred construction checklists by number and title.
2. Provide a target schedule for completion of deferred construction checklists.

3. Written approval of proposed deferred construction checklists, including approved schedule of completion of each deferred construction checklist.

G. Delayed Construction Checklists: Obtain Owner approval of proposed delayed construction checklists, including proposed schedule of completion of each delayed construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, delayed construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:

1. Identify delayed construction checklist by construction checklist number and title.
2. Provide a target schedule for completion of delayed construction checklists.
3. Written approval of proposed delayed construction checklists, including approved schedule of completion of each delayed construction checklist.

3.3 GENERAL EXECUTION REQUIREMENTS

A. Schedule and coordinate commissioning process with the Construction Schedule.

B. Perform activities identified in construction checklists, including tests, and document results of actions as construction proceeds.

C. Perform test demonstrations for Owner's witness. Unless otherwise indicated, demonstrate tests for 100 percent of work to which the test applies. In some instances, demonstration of a random sample of other than 100 percent of the results of a test is specified.

1. On determination of the sample size, the samples shall be selected randomly by Owner's witness at the time of the test demonstration.
2. Include in the Commissioning Plan a detailed list of the test demonstrations with lot and sample quantities for each test.

D. Report test data and commissioning issue resolutions.

E. Schedule personnel to participate in and perform Commissioning-Process Work.

F. Installing contractors' commissioning responsibilities include, but are not limited to, the following:

1. Operating the equipment and systems they install during tests.
2. In addition, installing contractors may be required to assist in tests of equipment and systems with which their work interfaces.

3.4 COMMISSIONING COORDINATOR RESPONSIBILITIES

A. Management and Coordination: Manage, schedule, and coordinate commissioning process, including, but not limited to, the following:

1. Coordinate with subcontractors on their commissioning responsibilities and activities.

2. Obtain, assemble, and submit commissioning documentation.
3. Conduct periodic on-site commissioning meetings. Comply with requirements in Section 013100 "Project Management and Coordination."
4. Develop and maintain the commissioning schedule. Integrate commissioning schedule into the Construction Schedule. Update Construction Schedule at specified intervals.
5. Review and comment on preliminary test procedures and data forms.
6. Report inconsistencies and issues in system operations.
7. Verify that tests have been completed and results comply with acceptance criteria, and that equipment and systems are ready before scheduling test demonstrations.
8. Direct and coordinate test demonstrations.
9. Coordinate witnessing of test demonstrations by Owner's witness.
10. Coordinate and manage training. Be present during training sessions to direct video recording, present training, and direct the training presentations of others. Comply with requirements in Section 017900 "Demonstration and Training."
11. Prepare and submit specified commissioning reports.
12. Track commissioning issues until resolution and retesting is successfully completed.
13. Retain original records of Commissioning-Process Work, organized as required for the commissioning report. Provide Owner's representative access to these records on request.
14. Assemble and submit commissioning report.

3.5 COMMISSIONING TESTING

A. Quality Control: Construction checklists, including tests, are quality-control tools designed to improve the functional quality of Project. Test demonstrations evaluate the effectiveness of Contractor's quality-control process.

B. Owner's witness will be present to witness commissioning work requiring the signature of an owner's witness, including, but not limited to, test demonstrations. Owner's project manager will coordinate attendance by Owner's witness with Contractor's published Commissioning Schedule. Owner's witness will provide no labor or materials in the commissioning work. The only function of Owner's witness will be to observe and comment on the progress and results of commissioning process.

C. Construction Checklists:

1. Complete construction checklists as Work is completed.
2. Distribute construction checklists to installing contractors before they start work.
3. Installers:

    a. Verify installation using approved construction checklists as Work proceeds.

4. Provide Commissioning Authority access to construction checklists.

D. Installation Compliance Issues: Record as an installation compliance issue Work found to be incomplete, inaccessible, at variance with the Contract Documents, nonfunctional, or that does not comply with construction checklists. Record installation compliance issues on the construction checklist at the time they are identified. Record corrective

action and how future Work should be modified before signing off the construction checklist.

E. Pre-Startup Audit: Prior to executing startup procedures, review completed installation checks to determine readiness for startup and operation. Report conditions, which, if left uncorrected, adversely impact the ability of systems or equipment to operate satisfactorily or to comply with acceptance criteria. Prepare pre-startup report for each system.

F. Test Procedures and Test Data Forms:

1. Test procedures shall define the step-by-step procedures to be used to execute tests and test demonstrations.
2. Test procedures shall be specific to the make, model, and application of the equipment and systems being tested.
3. Completed test data forms are the official records of the test results.
4. Commissioning Authority will provide to Contractor preliminary test procedures and test data forms for performance tests and commissioning tests after approval of Product Data, Shop Drawings, and preliminary operation and maintenance manual.
5. Review preliminary test procedures and test data forms, and provide comments within 14 days of receipt from Commissioning Authority. Review shall address the following:

    a. Equipment protection and warranty issues, including, but not limited to, manufacturers' installation and startup recommendations, and operation and maintenance instructions.
    b. Applicability of the procedure to the specific software, equipment, and systems approved for installation.

6. After Contractor has reviewed and commented on the preliminary test procedures and test data forms, Commissioning Authority will revise and reissue the approved revised test procedures and test data forms marked "Approved for Testing."
7. Use only approved test procedures and test data forms marked "Approved for Testing" to perform and document tests and test demonstrations.

G. Performance of Tests:

1. The sampling rate for tests is 100 percent. The sampling rate for test demonstrations is 100 percent unless otherwise indicated.
2. Perform and complete each step of the approved test procedures in the order listed.
3. Record data observed during performance of tests on approved data forms at the time of test performance and when the results are observed.
4. Record test results that are not within the range of acceptable results on commissioning issue report forms in addition to recording the results on approved test procedures and data forms according to the "Commissioning Compliance Issues" Paragraph in this Article.
5. On completion of a test, sign the completed test procedure and data form. Tests for which test procedures and data forms are incomplete, not signed, or which indicate performance that does not comply with acceptance criteria will be

rejected. Tests for which test procedures and data forms are rejected shall be repeated and results resubmitted.

H. Performance of Test Demonstration:

1. Perform test demonstrations on a sample of tests after test data submittals are approved. The sampling rate for test demonstrations shall be 100 percent unless otherwise indicated in the individual test specification.
2. Notify Owner's witness at least three days in advance of each test demonstration.
3. Perform and complete each step of the approved test procedures in the order listed.
4. Record data observed during performance of test demonstrations on approved data forms at the time of demonstration and when the results are observed.
5. Provide full access to Owner's witness to directly observe the performance of all aspects of system response during the test demonstration. On completion of a test demonstration, sign the completed data form and obtain signature of Owner's witness at the time of the test to authenticate the reported results.
6. Test demonstration data forms not signed by Contractor and Owner's witness at the time of the completion of the procedure will be rejected. Test demonstrations for which data forms are rejected shall be repeated and results shall be resubmitted.

    a. Exception for Failure of Owner's Witness to Attend: Failure of Owner's witness to be present for agreed-on schedule of test demonstration shall not delay Contractor. If Owner's witness fails to attend a scheduled test, Contractor shall proceed with the scheduled test. On completion, Contractor shall sign the data form for Contractor and for Owner's witness, and shall note the absence of Owner's witness at the scheduled time and place.

7. False load test requirements are specified in related sections.

    a. Where false load testing is specified, provide temporary equipment, power, controls, wiring, piping, valves, and other necessary equipment and connections required to apply the specified load to the system. False load system shall be capable of steady-state operation and modulation at the level of load specified. Equipment and systems permanently installed in this work shall not be used to create the false load without Architect's written approval.

I. Deferred Tests:

1. Deferred Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed deferred tests or other tests approved for deferral until specified seasonal or other conditions are available. When approved, deferred tests may be completed after the date of Construction-Phase Commissioning Completion. Identify proposed deferred tests in the request for Certificate of Construction-Phase Commissioning Process Completion as follows:

    a. Identify deferred tests by number and title.
    b. Provide a target schedule for completion of deferred tests.

2. Schedule and coordinate deferred tests. Schedule deferred tests when specified conditions are available. Notify Architect and Commissioning Authority at least three working days (minimum) in advance of tests.
3. Where deferred tests are specified, coordinate participation of necessary personnel and of Architect, Commissioning Authority, and Owner's witness. Schedule deferred tests to minimize occupant and facility impact. Obtain Architect's approval of the proposed schedule.

J. Delayed Tests:

1. Delayed Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed delayed tests. Obtain Owner approval of proposed delayed tests, including proposed schedule of completion of each delayed test, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. Include the following in the request for Certificate of Construction-Phase Commissioning Process Completion:

    a. Identify delayed tests by test number and title.
    b. Written approval of proposed delayed tests, including approved schedule of completion of delayed tests.

2. Schedule and coordinate delayed tests. Schedule delayed tests when conditions that caused the delay have been rectified. Notify Architect and Commissioning Authority at least three working days (minimum) in advance of tests.
3. Where delayed tests are approved, coordinate participation of necessary personnel and of Architect, Commissioning Authority, and Owner's witness. Schedule delayed tests to minimize occupant and facility impact. Obtain Architect's approval of the proposed schedule.

K. Commissioning Compliance Issues:

1. Test results that are not within the range of acceptable results are commissioning compliance issues.
2. Track and report commissioning compliance issues until resolution and retesting are successfully completed.
3. If a test demonstration fails, determine the cause of failure. Direct timely resolution of issue and then repeat the demonstration. If a test demonstration must be repeated due to failure caused by Contractor work or materials, reimburse Owner for billed costs for the participation in the repeated demonstration.
4. Test Results: If a test demonstration fails to meet the acceptance criteria, perform the following:

    a. Complete a commissioning compliance issue report form promptly on discovery of test results that do not comply with acceptance criteria.
    b. Submit commissioning compliance issue report form within 48 hours of the test.
    c. Determine the cause of the failure.
    d. Establish responsibility for corrective action if the failure is due to conditions found to be Contractor's responsibility.

5. Commissioning Compliance Issue Report: Provide a commissioning compliance issue report for each issue. Do not report multiple issues on the same commissioning compliance issue report.

    a. Exception: If an entire class of devices is determined to exhibit the identical issue, they may be reported on a single commissioning compliance issue report. (For example, if all return-air damper actuators that are specified to fail to the open position are found to fail to the closed position, they may be reported on a single commissioning issue report. If a single commissioning issue report is used for multiple commissioning compliance issues, each device shall be identified in the report, and the total number of devices at issue shall be identified.
    b. Complete and submit Part 1 of the commissioning compliance issue report immediately when the condition is observed.
    c. Record the commissioning compliance issue report number and describe the deficient condition on the data form.
    d. Resolve commissioning compliance issues promptly. Complete and submit Part 2 of the commissioning compliance issue report when issues are resolved.

6. Diagnose and correct failed test demonstrations as follows:

    a. Perform diagnostic tests and activities required to determine the fundamental cause of issues observed.
    b. Record each step of the diagnostic procedure prior to performing the procedure. Update written procedure as changes become necessary.
    c. Record the results of each step of the diagnostic procedure.
    d. Record the conclusion of the diagnostic procedure on the fundamental cause of the issue.
    e. Determine and record corrective measures.
    f. Include diagnosis of fundamental cause of issues in commissioning compliance issue report.

7. Retest:

    a. Schedule and repeat the complete test procedure for each test demonstration for which acceptable results are not achieved. Obtain signature of Owner's witness on retest data forms. Repeat test demonstration until acceptable results are achieved. Except for issues that are determined to result from design errors or omissions, or other conditions beyond Contractor's responsibility, compensate Owner for direct costs incurred as the result of repeated test demonstrations to achieve acceptable results.
    b. For each repeated test demonstration, submit a new test data form, marked "Retest."

8. Do not correct commissioning compliance issues during test demonstrations.

    a. Exceptions will be allowed if the cause of the issue is obvious and resolution can be completed in less than five minutes. If corrections are made under this exception, note the deficient conditions on the test data form and issue

a commissioning compliance issue report. A new test data form, marked "Retest," shall be initiated after the resolution has been completed.

3.6 COMMISSIONING MEETINGS

A. Commissioning Authority will schedule and conduct commissioning meetings. Comply with requirements in Section 013100 "Project Management and Coordination."

3.7 SEQUENCING

A. Sequencing of Commissioning Verification Activities: For a particular material, item of equipment, assembly, or system, perform the following in the order listed unless otherwise indicated:

1. Construction Checklists:

a. Material checks.
b. Installation checks.
c. Startup, as appropriate. Some startup may depend on component performance. Such startup may follow component performance tests on which the startup depends.
d. Performance Tests:

1) Static tests, as appropriate.
2) Component performance tests. Some component performance tests may depend on completion of startup. Such component performance tests may follow startup.
3) Equipment and assembly performance tests.
4) System performance tests.
5) Intersystem performance tests.

2. Commissioning tests.

B. Before performing commissioning tests, verify that materials, equipment, assemblies, and systems are delivered, installed, started, and adjusted to perform according to construction checklists.

C. Verify readiness of materials, equipment, assemblies, and systems by performing tests prior to performing test demonstrations. Notify Architect if acceptable results cannot be achieved due to conditions beyond Contractor's control or responsibility.

D. Commence tests as soon as installation checks for materials, equipment, assemblies, or systems are satisfactorily completed. Tests of a particular system may proceed prior to completion of other systems, provided the incomplete work does not interfere with successful execution of test.

3.8 SCHEDULING

A. Commence commissioning process as early in the construction period as possible.

B. Commissioning Schedule: Integrate commissioning activities into Construction Schedule. See Section 013200 "Construction Progress Documentation."

1. Include detailed commissioning activities in monthly updated Construction Schedule and short-interval schedule submittals.
2. Schedule the start date and duration for the following commissioning activities:

    a. Submittals.
    b. Preliminary operation and maintenance manual submittals.
    c. Installation checks.
    d. Startup, where required.
    e. Performance tests.
    f. Performance test demonstrations.
    g. Commissioning tests.
    h. Commissioning test demonstrations.

3. Schedule shall include a line item for each installation check, startup, and test activity specific to the equipment or systems involved.
4. Determine milestones and prerequisites for commissioning process. Show commissioning milestones, prerequisites, and dependencies in monthly updated critical-path-method construction schedule and short-interval schedule submittals.

C. Two-Week Look-Ahead Commissioning Schedule:

1. Two weeks prior to the beginning of tests, submit a detailed two-week look-ahead schedule. Thereafter, submit updated two-week look-ahead schedules weekly for the duration of commissioning process.
2. Two-week look-ahead schedules shall identify the date, time, beginning location, Contractor personnel required, and anticipated duration for each startup or test activity.
3. Use two-week look-ahead schedules to notify and coordinate participation of Owner's witnesses.

D. Owner's Witness Coordination:

1. Coordinate Owner's witness participation via Architect.
2. Notify Architect of commissioning schedule changes at least five work days in advance for activities requiring the participation of Owner's witness.

3.9 COMMISSIONING REPORTS

A. Test Reports:

1. Pre-startup reports include observations of the conditions of installation, organized into the following sections:

    a. Equipment Model Verification: Compare contract requirements, approved submittals, and provided equipment. Note inconsistencies.
    b. Preinstallation Physical Condition Checks: Observe physical condition of equipment prior to installation. Note conditions including, but not limited to, physical damage, corrosion, water damage, or other contamination or dirt.

c. Preinstallation Component Verification Checks: Verify components supplied with the equipment, preinstalled or field installed, are correctly installed and functional. Verify external components required for proper operation of equipment correctly installed and functional. Note missing, improperly configured, improperly installed, or nonfunctional components.
d. Summary of Installation Compliance Issues and Corrective Actions: Identify installation compliance issues and the corrective actions for each. Verify that issues noted have been corrected.
e. Evaluation of System Readiness for Startup: For each item of equipment for each system for which startup is anticipated, document in summary form acceptable to Owner completion of equipment model verification, preinstallation physical condition checks, preinstallation component verification checks, and completion of corrective actions for installation compliance issues.

2. Test data reports include the following:

a. "As-tested" system configuration. Complete record of conditions under which the test was performed, including, but not limited to, the status of equipment, systems, and assemblies; temporary adjustments and settings; and ambient conditions.
b. Data and observations, including, but not limited to, data trend logs, recorded during the tests.
c. Signatures of individuals performing and witnessing tests.
d. Data trend logs accumulated overnight from the previous day of testing.

3. Commissioning Compliance Issue Reports: Report as commissioning compliance issues results of tests and test demonstrations that do not comply with acceptance criteria. Report only one issue per commissioning compliance issue report. Use sequentially numbered facsimiles of commissioning compliance issue report form included in this Section, or other form approved by Owner. Distribute commissioning compliance issue reports to parties responsible for taking corrective action. Identify the following:

a. Commissioning compliance issue report number. Assign unique, sequential numbers to individual commissioning compliance issue reports when they are created, to be used for tracking.
b. Action distribution list.
c. Report date.
d. Test number and description.
e. Equipment identification and location.
f. Briefly describe observations about the performance associated with failure to achieve acceptable results. Identify the cause of failure if apparent.
g. Diagnostic procedure or plan to determine the cause (include in initial submittal)
h. Diagnosis of fundamental cause of issues as specified below (include in resubmittal).
i. Fundamental cause of unacceptable performance as determined by diagnostic tests and activities.

j. When issues have been resolved, update and resubmit the commissioning issue report forms by completing Part 2. Identify resolution taken and the dates and initials of the persons making the entries.
k. Schedule for retesting.

4. Weekly progress reports include information for tests conducted since the preceding report and the following:

a. Completed data forms.
b. Equipment or system tested, including test number, system or equipment tag number and location, and notation about the apparent acceptability of results.
c. Activities scheduled but not conducted per schedule.
d. Commissioning compliance issue report log.
e. Schedule changes for remaining Commissioning-Process Work, if any.

5. Data trend logs shall be initiated and running prior to the time scheduled for the test demonstration.

a. Trend log data format shall be multiple data series graphs. Where multiple data series are trend logged concurrently, present the data on a common horizontal time axis. Individual data series may be presented on a segmented vertical axis to avoid interference of one data series with another, and to accommodate different axis scale values. Graphs shall be sufficiently clear to interpret data within the accuracy required by the acceptance criteria.
b. Attach to the data form printed trend log data collected during the test or test demonstration.
c. Record, print out, and attach to the data form operator activity during the time the trend log is running. During the time the trend log is running, operator intervention not directed by the test procedure invalidates the test results.

6. System Alarm Logs: Record and print out a log of alarms that occurred since the last log was printed. Evaluate alarms to determine if the previous day's work resulted in any conditions that are not considered "normal operation."

a. Conditions that are not considered "normal operation" shall be reported on a commissioning issue report attached to the alarm log. Resolve as necessary. The intent of this requirement is to discover control system points or sequences left in manual or disabled conditions, equipment left disconnected, set points left with abnormal values, or similar conditions that may have resulted from failure to fully restore systems to normal, automatic control after test completion.

3.10 CERTIFICATE OF CONSTRUCTION-PHASE COMMISSIONING PROCESS COMPLETION

A. When Contractor considers that construction-phase commissioning process, or a portion thereof which Owner agrees to accept separately, is complete, Contractor shall prepare and submit to Owner and Commissioning Authority through Architect a comprehensive list of items to be completed or corrected. Failure to include an item on such list does not alter Contractor's responsibility to compete commissioning process.

B. On receipt of Contractor's list, Commissioning Authority will make an inspection to determine whether the construction-phase commissioning process or designated portion thereof is complete. If Commissioning Authority's inspection discloses items, whether included on Contractor's list, which is not sufficiently complete as defined in "Construction-Phase Commissioning Process Completion" Paragraph in the "Definitions" Article, Contractor shall, before issuance of the Certificate of Construction-Phase Commissioning Process Completion, complete or correct such items on notification by Commissioning Authority. In such case, Contractor shall then submit a request for another inspection by Commissioning Authority to determine construction-phase commissioning process completion.

C. Contractor shall promptly correct deficient conditions and issues discovered during commissioning process. Costs of correcting such deficient conditions and issues, including additional testing and inspections, the cost of uncovering and replacement, and compensation for Architect's and Commissioning Authority's services and expenses made necessary thereby, shall be at Contractor's expense.

D. When construction-phase commissioning process or designated portion is complete, Commissioning Authority will prepare a Certificate of Construction-Phase Commissioning Process Completion that shall establish the date of completion of construction-phase commissioning process. Certificate of Construction-Phase Commissioning Process Completion shall be submitted prior to requesting inspection for determining date of Substantial Completion.

END OF SECTION 019113

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SECTION 019115 – BUILDING ENCLOSURE COMMISSIONING REQUIREMENTS

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.

B. State of Utah, DFCM HPBS Functional Mockup Design, Preparation, and Testing Guide

1.02 SUMMARY

A. The work under this Section is subject to requirements of the Contract Documents, including the Owner's General Conditions and articles of the Construction Manager's General Conditions.

B. This Section summarizes the Building Enclosure Commissioning requirements and includes general requirements that apply to implementation of building enclosure commissioning without regard to specific products, systems, assemblies, or components. Refer to Section 019117 for Building Enclosure Functional Performance Testing Requirements.

1. The Building Enclosure Commissioning requirements in this Section are entirely separate from, and in addition to, the General Commissioning Requirements.

C. Building Enclosure Commissioning (BECx) is a quality control process designed to provide the Owner and General Contractor an assurance the enclosure systems responsible for environmental separation have been installed correctly in accordance with the Contract Documents, manufacturers installation instructions, and good industry practice. The BECx process is intended to achieve the following specific objectives:

1. Provide the Owner with an unbiased and objective view of the building enclosure installation, operation, and performance.
2. Verify building enclosure systems responsible for environmental separation, with respect to air, moisture, and thermal performance, perform interactively within the performance guidelines set forth in the design intent.
3. Verify and document the correct installation and acceptable performance of building enclosure products and systems.
4. Provide assurance to the Owner the building enclosure will have minimal performance issues within the warranty period for the products and systems commissioned.

D. Building Enclosure Commissioning does not take away from, or reduce responsibility of, system designers or installing contractors to provide a finished and fully functioning

product. This Section shall in no way diminish the responsibility of installers in performing all aspects of work and testing as outlined in the Contract Documents. Where conflicts occur regarding enclosure functional performance testing criteria Section 019117 shall supersede. Where conflicts occur regarding required enclosure functional performance testing the Architect, in consultation with the BECxA, will be the authority.

1.03 RELATED SECTIONS

A. Specific building enclosure commissioning requirements are given in this specification. The following specification sections are related to the work specified in this Section:

1. Division 01 – General Commissioning Requirements
2. Division 01 – Building Enclosure Functional Performance Requirements
3. Section 01 – Sustainable Design Requirements - HPBS
4. Division 03 – Concrete
5. Division 04 – Masonry
6. Division 07 – Thermal and Moisture Protection
7. Division 08 – Openings
8. Division 09 - Finishes

1.04 DEFINITIONS

A. Building Enclosure Commissioning Agent (BECxA): Contracted directly by the Owner. BECxA directs building enclosure commissioning activities, communicates directly with representatives of the project team, and leads efforts toward meeting the enclosure design intent.

B. Building Enclosure Testing Agent (BETA): Contracted directly by the owner. The BETA performs enclosure functional performance testing as directed by the BECxA. The BETA is often the same entity as the BECxA.

C. Commissioning Agent (CxA): Contracted to Owner. CxA directs building commissioning activities (typically mechanical and electrical systems) excluding BECx activities.

D. Building Enclosure Commissioning Plan (BECx Plan): Overall plan of building enclosure commissioning activities to provide information, criteria, schedule, and coordination.

E. Functional Performance Test (FPT): A standardized test of enclosure products, systems, or assemblies to determine the performance levels under simulated environmental conditions.

F. Test Specimen: The entire assembled unit submitted for test, including the joints and/or interfaces with adjacent products

G. Functional Mockup: A system of interfacing exterior components, representative of the enclosure, built specifically for performance testing. A mockup may be a stand alone structure or in-situ.

H. Deficiency: Condition of a building enclosure product, system, or assembly that is not in compliance with the Contract Documents, product installation instructions, or good industry practice.

I. Final Building Enclosure Commissioning Record (Final BECx Record): Overall record of all building enclosure commissioning activities provided at the conclusion of BECx activities.

1.05 COORDINATION

A. The BECxA shall receive a copy of all building enclosure related construction documents, submittals and shop drawings, addenda, and change orders directly from the Architect or General Contractor.

B. The BECxA shall distribute information and documentation to all responsible parties relative to the nature and extent of the communication.

C. The BECxA is primarily responsible to the Owner, and as such, shall regularly appraise the Owner, Architect, and General Contractor of enclosure progress, pending problems and/or deficiencies. Any potential change in the contractual and/or financial obligations of the Owner (credits, change orders, schedule changes, etc.) shall be identified as soon as possible.

D. The General Contractor shall incorporate BECx activities into the master construction schedule. The General Contractor is responsible for scheduling, notifications, and meeting minutes for these activities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SYSTEMS TO BE COMMISSIONED

A. Systems to be commissioned include all building enclosure products, systems, and assemblies responsible for providing environmental separation including but not limited to:

1. Below grade systems, such as foundation wall and slab on grade systems.
2. Roofing systems, such as membrane and vegetative roof systems.
3. Opaque wall and cladding systems, such as air barriers and metal panel systems.
4. Fenestrations, such as windows and skylights.
5. The interfaces between enclosure systems, such as sealants and expansion joints.

3.02 BUILDING ENCLOSURE COMMISSIONING IMPLEMENTATION

A. Design Phase Activities

1. Architect to schedule a Design BECx Kickoff Meeting to review the Building Enclosure Commissioning process specifically focused on Design Phase activities including milestones, responsibilities, point of contact and distribution, expectations, and preliminary design advice based on Owner priorities.
2. The BECxA will review the Owners Project Requirements regarding air, moisture, and thermal performance and make recommendations to meet the design intent.
3. BECxA to develop a preliminary Building Enclosure Commissioning Plan (BECx Plan) to be updated throughout the project.
4. The Architect will provide the BECxA with drawings and specifications, in an electronic format, at outlined milestones. The BECxA will provide a review based on air, moisture, and thermal performance of the enclosure. The review will consist of marked up conditions and general design advice. The BECxA will attend a BECx Design Meeting corresponding to each design review.

    a. Responses to all review comments is required. While the Architect is under no obligation to accept and incorporate all comments, an explanation for non-acceptance is expected.
    b. All drawing and specification review comments and responses will be reported to the Owner in the Final BECx Record closeout documentation.

5. The BECxA will assist in the value engineering effort regarding possible modifications to the proposed enclosure systems.
6. The BECxA will provide a Building Enclosure Commissioning Requirements specification to the Architect for incorporation into the Contract Documents.
7. The BECxA will provide a Functional Performance Testing Requirements specification to the Architect for incorporation into the Contract Documents.

B. Preconstruction Phase Activities

1. The Architect or General Contractor shall provide the BECxA with enclosure related documentation (submittals, manufacture's performance data, shop drawings, etc.) for review against the Contract Documents and design intent. This review should be performed prior to or concurrent with the Architect review.
2. The BECxA will assist in the review of Contract Document modifications, substitution requests, ASIs, and Change Orders for enclosure related products, systems, and assemblies.
3. The BECxA will develop a schedule of BECx activities and functional performance testing milestones for inclusion into the master construction schedule.
4. The BECxA will conduct a Preconstruction BECx Kickoff Meeting to review the Building Enclosure Commissioning process specifically focused on Construction activities including milestones, responsibilities, point of contact and distribution, expectations, testing, and common enclosure deficiency items.

    a. The Preconstruction BECx Kickoff Meeting should include representative of the Owner, Architect, General Contractor, and all enclosure related subcontractors (installers of the roof, sheathing, air barrier, masonry, glazing, and waterproofing systems)

C. Construction Phase Activities

1. The BECxA will participate in periodic enclosure meetings with representative of the Owner, Architect, General Contractor, and related subcontractors to discuss details and design considerations, scheduling, answer enclosure related questions, review ongoing deficiency list, and review functional performance testing.
2. The BECxA will review the mockup prior to the BETA functional performance testing to ensure the installation meets the requirements of the Contract Documents and is representative of the products and systems submitted.
3. The BECxA will participate in the functional performance testing of the mockup conducted by the BETA (the BECxA and BETA may be the same entity). Mockup testing will be conducted in accordance with specification section 019117 Building Enclosure Functional Performance Testing Requirements.

    a. The BECx will assist the General Contractor and related subcontractors in the determination of failure conditions and the appropriate method of remediation.
    b. Where testing indicates performance requirements are not met, the contractor shall repair or replace the failed sections. All costs associated with the repair and re-testing shall be the responsibility of the contractor. Retesting shall be conducted by the BETA under similar conditions which resulted in the initial failure, or as directed by the BECxA.

4. The BECxA will perform periodic site inspections to observe the ongoing installation of the building enclosure. Deviations from the Contract Documents, product installation instructions, or good industry practice will be noted in a BECx Observation Report.

    a. Conditions noted in the BECx Observation Report will be discussed with the General Contractor while on site. If a condition can be remediated during the site inspection it will be issued as closed.
    b. The BECx Observation Report will be distributed by the BECxA to the project team within 72 hours of the site inspection.
    c. Written responses to all noted conditions are required. While the General Contractor is under no obligation to accept and remediate all conditions, an explanation for non-acceptance is expected.
    d. All costs associated with the remediation of noted conditions shall be the responsibility of the contractor.
    e. The General Contractor shall verify, and allow the BECxA to verify, remediation of noted conditions prior to concealment or removal of access.
    f. All BECx Observation Reports and responses will be reported to the Owner in the Final BECx Record closeout documentation. Unresolved conditions may result in significant re-work time and cost if the Owner determines the condition deficient.

5. The BECxA will participate in the functional performance testing of the building conducted by the BETA (the BECxA and BETA may be the same entity). Building testing will be conducted in accordance with specification section 019117 Building Enclosure Functional Performance Testing Requirements.

a. The BECx will assist the General Contractor and related subcontractors in the determination of failure conditions and the appropriate method of remediation.
b. Where testing indicates performance requirements are not met, the contractor shall repair or replace the failed sections. All costs associated with the repair and re-testing shall be the responsibility of the contractor. Retesting shall be conducted by the BETA under similar conditions which resulted in the initial failure, or as directed by the BECxA.
c. Failed tests typically result in testing of additional similar locations at the discretion of the Owner. The costs of additional testing shall be the responsibility of the contractor. Testing shall be concluded only when satisfactory results are achieved.
d. If deficient conditions are observed during functional performance testing the testing may require re-scheduling. All costs associated with the re-scheduled testing shall be the responsibility of the contractor. The BECxA shall not overlook deficient work or loosen acceptance criteria to satisfy scheduling or cost concerns unless directed to do so in writing by the Owner.

6. The BECxA will participate in the E779 Whole Building Air Test (WBAT) conducted by the BETA (the BECxA and BETA may be the same entity). The Whole Building Air Test will be conducted in accordance with specification section 019117 Building Enclosure Functional Performance Testing Requirements.

a. The BECxA will conduct a WBAT Preparation Meeting approximately 1 month prior to the WBAT to explain the test procedure, preparation requirements, expectations, test requirements, and scheduling. The meeting should include representative of the Owner, Architect, General Contractor, CxA, controls, mechanical subcontractor, electrical subcontractor, and glazing subcontractor.
b. The BECxA will perform a site inspection in conjunction with the WBAT Preparation Meeting to address concerns specifically related to WBAT performance.
c. Results of the WBAT will be available immediately upon completion of testing. The BETA will provide a WBAT Field Test Report to the Owner, BECxA, Architect, and General Contractor, within 28 days of the conclusion of the testing activity.
d. If the results of the WBAT indicate the functional performance requirements have not been met the BECxA will assist the Owner and General Contractor in the development of a remediation plan. All costs associated with the remediation shall be the responsibility of the contractor, including but not limited to, selective demolition and repair, occupancy delays, additional BECx site inspections and testing, and other costs as determined by the Owner.

D. Closeout Activities

1. The General Contractor shall provide the BECxA with enclosure related operation and maintenance plans for review against the Contract Documents and design intent.

2. The BECxA will issue a Final BECx Record at the completion of all BECx activities. The Final BECx Record will include a summary of all BECx activities and an overall opinion to the buildings ability to meet performance goals. The Final BECx Record will include all drawing and specification reviews, comments and responses, BECx and FPT specifications, submittal reviews, observation reports, noted condition responses, functional performance test reports, and reviewed operational and maintenance plans.

END OF SECTION 019115

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SECTION 019117 - BUILDING ENCLOSURE FUNCTIONAL PERFORMANCE TESTING REQUIREMENTS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2015.

B. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints; 2019 (Reapproved 2020).

C. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers; 2022.

D. ASTM E779 - Standard Test Method for Determining Air Leakage Rate by Fan Pressurization; 2019.

E. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors; 2002 (Reapproved 2018).

F. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015 (Reapproved 2023).

G. ASTM E1186 - Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems; 2017.

1.02 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.

B. State of Utah, DFCM HPBS Functional Mockup Design, Preparation, and Testing Guide

1.03 SUMMARY

A. The work under this Section is subject to requirements of the Contract Documents, including the Owner's General Conditions and articles of the Construction Manager's General Conditions.

B. This Section includes the functional performance testing requirements for the Building Enclosure systems. Refer to Section 019115 for Building Enclosure Commissioning Requirements

C. Building Enclosure Functional Performance Testing does not take away from, or reduce responsibility of, system designers or installing contractors to provide a finished and fully functioning product. This Section shall in no way diminish the responsibility of installers in performing all aspects of work and testing as outlined in the Contract Documents. Where conflicts occur regarding enclosure functional performance testing criteria this Section shall supersede. Where conflicts occur regarding required enclosure functional performance testing the Architect, in consultation with the BECxA, will be the authority.

1.04 RELATED SECTIONS

A. Specific building enclosure functional performance testing requirements are given in this Section. The following specification sections are related to the work specified in this Section:

1. Division 01 – General Commissioning Requirements
2. Division 01 – Building Enclosure Commissioning Requirements
3. Division 03 – Concrete
4. Division 04 – Masonry
5. Division 07 – Thermal and Moisture Protection
6. Division 08 – Openings

1.05 DEFINITIONS

A. Building Enclosure Commissioning Agent (BECxA): Contracted directly by the Owner. BECxA directs building enclosure commissioning activities, communicates directly with representatives of the project team, and leads efforts toward meeting the enclosure design intent.

B. Building Enclosure Testing Agent (BETA): Contracted directly by the owner. The BETA performs enclosure functional performance testing as directed by the BECxA. The BETA is often the same entity as the BECxA.

C. Commissioning Agent (CxA): Contracted to Owner. CxA directs building commissioning activities (typically mechanical and electrical systems) excluding BECx activities.

D. Functional Performance Test (FPT): A standardized test of enclosure products, systems, or assemblies to determine the performance levels under simulated environmental conditions.

E. Test Specimen: The entire assembled unit submitted for test, including the joints and/or interfaces with adjacent products

F. Functional Mockup: A system of interfacing exterior components, representative of the enclosure, built specifically for performance testing. A mockup may be a stand alone structure or in-situ.

G. Deficiency: Condition of a building enclosure product, system, or assembly that is not in compliance with the Contract Documents, product installation instructions, or good industry practice.

1.06 COORDINATION

A. The General Contractor shall coordinate the testing activities with the BECxA. Testing activities should be attended by representatives of the Owner, Architect, General Contractor, and all enclosure related subcontractors whose systems are being evaluated. The General Contractor is responsible for testing activity scheduling and notifications.

B. The General Contractor shall coordinate the sequencing of installation to allow testing of the products and systems prior to the installation of exterior claddings and insulation. Additionally, interior insulation and gypsum wall board should not be installed within 3 feet of the test locations.

1.07 REPORTING

A. The BETA will provide a Field Test Report to the Owner, BECxA, Architect, and General Contractor, within 14 days of the conclusion of the testing activity. Field Test Reports shall be in conformance with the reporting requirements of the Test Method(s) utilized.

B. The BETA shall provide a final summary report to the BECxA at the conclusion of all testing to be included in the BECxA closeout documentation.

1.08 PERFORMANCE REQUIREMENTS

A. The functional performance criteria below apply to all mockup and field testing of exterior enclosure components.

1. Curtain Wall/Storefront/Window Wall/Fenestrations

    a. ASTM E783 – Maximum air leakage of 0.09 cfm/sf when tested under a differential air pressure of 6.24 psf.
    b. ASTM E1105 – No uncontrolled water leakage when tested under a differential air pressure of 8.0 psf.
    c. AAMA 501.2 – No uncontrolled water leakage when tested at 30 psi water pressure (used diagnostically to assist in leakage identification).
    d. ASTM E1521 (Method A) – Cohesive failure after sealant elongation percentage requirement.

2. Skylights

    a. AAMA 501.2 – No uncontrolled water leakage when tested at 30 psi water pressure.

3. Air Barrier/Air Barrier Assemblies

a. ASTM E783 – Maximum air leakage of 0.04 cfm/sf when tested under a differential air pressure of 1.57 psf.
b. ASTM E1186 (4.2.6) – Qualitative air testing performed in conjunction with ASTM E783. No performance requirements.
c. ASTM E1186 (4.2.7) – No bubbles shall be observed in the leak detection liquid.
d. ASTM D4541 – Minimum adhesion strength of 16 lbf/sq. inch.
e. ASTM E1105 – No uncontrolled water leakage when tested under a differential air pressure of 8.0 psf.

4. Roof Systems

a. ASTM E1186 (4.2.7) – No bubbles shall be observed in the leak detection liquid.

5. Whole Building

a. ASTM E779 – Maximum air leakage of 0.25 cfm/sf when tested under a differential air pressure of 75 Pa.
b. ASTM E1186 (4.2.1) – Qualitative infrared thermography performed in conjunction with ASTM E779. No performance requirements.
c. The ASTM E779 and ASTM E1186 (4.2.1), Whole Building Air Test (WBAT) and Infrared Thermography.

B. Water leakage is only acceptable if all the following conditions are satisfied:

1. Water is contained and drained to the exterior through the correct operation of the system.
2. There is no wetting of a surface that would be visible to the building occupants.
3. There would be no staining or other damage to the completed building or finishes.

C. Where testing indicates performance requirements are not met, the contractor shall repair or replace the failed sections. All costs associated with the repair and re-testing shall be the responsibility of the contractor. Retesting shall be conducted by the BETA under similar conditions which resulted in the initial failure, or as directed by the BECxA.

D. Failed tests typically result in testing of additional similar locations at the discretion of the Owner. The costs of additional testing shall be the responsibility of the contractor. Testing shall be concluded only when satisfactory results are achieved.

1.09 MOCKUP TEST REQUIREMENTS

A. An in-situ functional performance mockup of the enclosure shall be constructed. The in-situ mockup is typically a section of the building completed ahead of the schedule for the purpose of testing. The mockup shall be constructed air and water tight using the same materials, installation, personnel, and details as the building.

1. The in-situ mockup should include:

a. At least two window systems representative of the typical window type to be used on the building,
b. wall-to-foundation interfaces,
c. a representative sample of each cladding attachment mechanism, testing requires special installation of continuous z-girts or cladding receptors as they must be installed in a section no longer than 13 inches,
d. no less than 100 sf of opaque wall surrounding the window systems,
e. typical air barrier penetrations such as pipe and conduits (these may be removed and patched after testing is complete if they are not in proper position),
f. access to the interior.

2. Exterior claddings and insulation should not be installed prior to testing.
3. Interior finishes, interior gypsum wall board, or insulation should not be installed prior to mockup testing.

B. The coordination and construction of the mockup is the responsibility of the General Contractor.

C. Further enclosure elements should not be installed on the building prior to the completion of all functional performance tests on the mockup.

D. The General Contractor is required to provide the BETA: free and clear access to the test areas, lifts and/or scaffolding as required to fully access the interior and exterior of the test specimens, a water source capable of providing 5 gallons of water per hour per square foot of the test specimen (within 200 ft of the test area), a 110-volt power supply (within 100 ft of the test area), and temporary protection of venerable areas from excess moisture related to functional performance testing.

E. The functional performance testing of the mockup may include:

1. AAMA 501.2, Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems
2. ASTM C1521 (Method A), Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
3. ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
4. ASTM E783 (modified), Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
5. ASTM E1105, Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference
6. ASTM E1186 (Practice 4.2.6), Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems – Smoke Tracers
7. ASTM E1186 (Practice 4.2.7), Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems – Bubble Test

1.10 FIELD TEST REQUIREMENTS

A. Field testing should be completed prior to the installation of exterior claddings and insulation. Additionally, interior insulation and gypsum wall board should not be installed within 3 feet of the test locations.

B. The General Contractor is required to provide the BETA: free and clear access to the test areas, lifts and/or scaffolding as required to fully access the interior and exterior of the test specimens, a water source capable of providing 5 gallons of water per hour per square foot of the test specimen (within 200 ft of the test area), a 110-volt power supply (within 100 ft of the test area), and temporary protection of venerable areas from excess moisture related to functional performance testing.

C. The functional performance testing of the building may include:

1. AAMA 501.2, Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems
2. ASTM C1521 (Method A), Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
3. ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
4. ASTM E779, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization (to be performed at the owner's discretion)

    a. Enclosure area square footage calculations are required from the Architect at least 30 days prior to the test.
    b. Significant preparations of the building are required by the General Contractor prior to the E779 Whole Building Air Test, including but not limited to:

        1) the building to remain unoccupied for the duration of the testing,
        2) intentional openings such as air intakes, louvers, damper, and vents must be sealed,
        3) exterior doors and windows closed and locked,
        4) interior doors and selected ceiling tiles must be opened to allow consistent pressurization,
        5) plumbing traps primed,
        6) mechanical equipment must be disabled or put in standby mode.

5. ASTM E783 (modified), Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
6. ASTM E1105, Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference
7. ASTM E1186 (Practice 4.2.1), Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems – Infrared Thermography (performed in conjunction with ((ASTM E779)))
8. ASTM E1186 (Practice 4.2.6), Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems – Smoke Tracers
9. ASTM E1186 (Practice 4.2.7), Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems – Bubble Test

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 019117

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DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 024100 - DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Selective demolition of built site elements.

B. Modification of existing utilities and utility structures.

1.02 RELATED REQUIREMENTS

A. Section 011000 - Summary: Limitations on Contractor's use of site and premises.

B. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.

C. Section 017000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

D. Section 311000 - Site Clearing: Vegetation and existing debris removal; earth stripping and stockpiling.

E. Section 312200 - Grading: Rough and fine grading.

PART 3 EXECUTION

2.01 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.

1. Obtain required permits.
2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
3. Provide, erect, and maintain temporary barriers and security devices.
4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
5. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.

6. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
7. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.

B. Do not begin removal until receipt of notification to proceed from Owner.

C. Protect existing structures and other elements to remain in place and not removed.

1. Provide bracing and shoring.
2. Prevent movement or settlement of adjacent structures.
3. Stop work immediately if adjacent structures appear to be in danger.

2.02 EXISTING UTILITIES

A. Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.

E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.

F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

2.03 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 024100

SECTION 030516 - UNDERSLAB VAPOR BARRIER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sheet vapor barrier under concrete slabs on grade.

1.02 RELATED REQUIREMENTS

A. Section 031000 - Concrete Forming and Accessories: Forms and accessories for formwork.

B. Section 032000 - Concrete Reinforcing.

C. Section 033000 - Cast-in-Place Concrete: Preparation of subgrade, granular fill, placement of concrete.

D. Section 033511-Concrete Floor Finishes;

1.03 SUBMITTALS

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

B. Product Data: Submit manufacturers' data on manufactured products.

C. Samples: Submit samples of underslab vapor barrier to be used.

D. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Underslab Vapor Barrier:

1. Water Vapor Permeance: Not more than 0.010 perms, maximum.
2. Complying with ASTM E1745 Class A.
3. Thickness: 15 mils.
4. Basis of Design:

a. Stego Industries LLC; Stego Wrap Vapor Barrier (15-mil): www.stegoindustries.com/#sle.
b. Grace Construction Products; W.R. Grace & Co..
c. W.R. Meadows, Inc..
d. Substitutions: See Section 016000 - Product Requirements.

B. Accessory Products: Vapor barrier manufacturer's recommended tape, adhesive, mastic, etc., for sealing seams and penetrations in vapor barrier.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surface over which vapor barrier is to be installed is complete and ready before proceeding with installation of vapor barrier.

3.02 INSTALLATION

A. Install vapor barrier in accordance with manufacturer's instructions and ASTM E1643.

B. Install vapor barrier under interior slabs on grade; lap sheet over footings and seal to foundation walls.

C. Lap joints minimum 6 inches.

D. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.

E. No penetration of vapor barrier is allowed except for reinforcing steel and permanent utilities.

F. Repair damaged vapor retarder before covering with other materials.

END OF SECTION 030516

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Formwork for cast-in-place concrete, with shoring, bracing and anchorage.

B. Formwork for cast-in-place Architectural Grade Concrete.

C. Openings for other work.

D. Form accessories.

E. Form stripping.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

B. Section 032000 - Concrete Reinforcing.

C. Section 033000 - Cast-in-Place Concrete.

D. Section 042000 - Unit Masonry: Reinforcement for masonry.

E. Section 051200 - Structural Steel Framing: Placement of embedded steel anchors and plates in cast-in-place concrete.

1.03 REFERENCE STANDARDS

A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).

B. ACI PRC-347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).

C. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).

D. ACI SPEC-301 - Specifications for Concrete Construction; 2020.

E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

G. PS 1 - Structural Plywood; 2023.

H. Cast-in-Place Architectural Concrete: Concrete that is exposed to view, is designated as architectural concrete, and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.

1.04 SUBMITTALS

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

B. Product Data: Provide data on void form materials and installation requirements.

C. Sustainable Design Submittals:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for low VOC content.

D. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.

E. Shop Drawings: For Architectural Grade concrete walls.

1. Show formwork construction, including form-liner layout, form-liner termination details, dimensioned locations of form-facing material joints, rustications, construction and contraction joints, form joint-sealant details, form-tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

    (a) Included separate layout for formwork used in field sample panels and mockups.
    (b) Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
    (c) Location of construction joints is subject to approval of Architect.

F. Samples: Submit two, 12 inch long samples of construction joint devices.

G. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Curing process.

1.05 QUALITY ASSURANCE

A. Maintain one copy of each installation standard on site throughout the duration of concrete work.

1.06 MOCK-UPS

A. Construct a mock-up of formwork for sandwich panel stemwall, 14 feet long by 9 feet wide. Refer to Sheet A110.

1. Include reinforcement, ties, and accessories specified in Section 032000.
2. Provide concrete in accordance with provisions of Section 033000.

B. Mockups: Before casting architectural concrete, build mockups, using the same procedures, equipment, materials, finishing procedures, and curing procedures that will be used for producing architectural concrete, to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, color, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Build mockups of typical wall of cast-in-place architectural concrete as shown on Drawings, including vertical and horizontal rustication joints, and any sculptured features.
3. Construct mockups to include at least two lifts having heights equal to those anticipated for construction.
4. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
5. In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair to match adjacent undamaged surfaces.
6. In presence of Architect, demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
7. Obtain Architect's approval of mockups before casting architectural concrete.
8. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Locate mock-ups where directed.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver prefabricated forms and installation instructions in manufacturer's packaging.

PART 2 PRODUCTS

2.01 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.

D. Comply with relevant portions of ACI CODE-318, ACI PRC-347, and ACI SPEC-301.

2.02 WOOD FORM MATERIALS

A. Softwood Plywood: PS 1, B-B High Density Concrete Form Overlay, Class I.

2.03 REMOVABLE PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gauge, 0.0598 inch thick, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

B. Preformed Aluminum Forms: ASTM B221 (ASTM B221M), 6061-T6 alloy, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

C. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

2.04 FORMWORK ACCESSORIES

A. Form Ties: Snap-off type, galvanized metal, fixed length, free of defects that could leave holes larger than **1 inch** in concrete surface, **3/4 inch (19 mm)** for Architectural Grade concrete.

B. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.

1. Do not use materials containing diesel oil or petroleum-based compounds.

C. Filler Strips for Chamfered Corners: Rigid plastic type; 3/4 x 3/4 inch size; maximum possible lengths.

D. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 051200.

E. Waterstops: Polymer-modified bentonite.

1. Configuration: Strip.
2. Size: Manufacturer's standard.
3. Manufacturers:

1. Tremco CPG Inc.; Superstop: www.tremcosealants.com.
2. Henry, a Carlisle Company; MiraSTOP BW: www.henry.com.
3. W. R. Meadows, Inc.; WATERSTOP EC: www.wrmeadows.com.
4. Substitutions: See Section 016000 - Product Requirements.

F. Surface Retarder: Water-soluble chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed architectural concrete surface to depth of aggregate exposure specified.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
2) Master Builders Solutions.
3) W. R. Meadows, Inc.

2. Source Limitations: Obtain surface retarder from single source from single manufacturer.

2.05 STEMWALL INSULATION SYSTEM

A. The Thermomass Building Insulation System, as supplied by Thermomass P.O. Box 950, Boone, Iowa 50036 (1-800-232-1748), consisting of both:

B. Insulation: Extruded Polystyrene Board Insulation: Complying with ASTM C 578, Type IV; with regularly spaced holes identifying connector placement locations.

C. Structurally Non-Composite Wythe Tie Connectors: Non-conductive, non-corrosive, fiber-composite connectors having a minimum tensile strength of 120,000 psi. minimum glass content of 76 percent by weight, and a coefficient of thermal expansion of 3.90 x10-6in/in/°F, nominal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 ERECTION - FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI SPEC-301.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

D. Align joints and make watertight. Keep form joints to a minimum.

E. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect before proceeding.

F. Limit cast-in-place architectural concrete surface irregularities, as follows:

1. Surface Finish-1.0: ACI 117 (ACI 117M) Class D, 1 inch (25 mm).
2. Surface Finish-2.0: ACI 117 (ACI 117M) Class B, 1/4 inch (6 mm).
3. Surface Finish-3.0: ACI 117 (ACI 117M) Class A, 1/8 inch (3.0 mm).

H. Construct forms to result in cast-in-place architectural concrete that complies with ACI 117 (ACI 117M).

1. Seal form joints, chamfers, rustication joints, and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.

    1. Provide closure backing materials if indented rustication is used over a ribbed form line, and seal joint between rustication strip and form with joint sealant.

2. Chamfer exterior corners and edges of cast-in-place architectural concrete.

3. Coat contact surfaces of wood rustications and chamfer strips with wood sealer before placing reinforcement, anchoring devices, and embedded items.

4. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

5. Coat contact surfaces of forms with surface retarder, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

3.03 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

3.04 STEMWALL INSULATION SYSTEM INSTALLATION

A. Sandwich Walls:

1. Set formwork in accordance with standard assembly practices, including form ties.
2. Before installation of the insulation sheets in the forms, tape the individual sheets together per the drawings supplied by Thermomass. Install the tape on both sides of the insulation. Apply the tape only to clean, dry surface.
3. Install the insulation assembly in the form.
4. Install the Thermomass connectors.

    1. Insert the connector in the rectangular hole in the twist-lock assembly.
    2. Push the connector through the thickness of the insulation until the wing comes to rest against the face of the twist-lock assembly.
    3. Using the wing for leverage, use the thumb and index finger to twist the connector in the directions indicated by the arrows on the face of the twist-lock assembly. Note that the connectors will rotate 90 degrees until internal detent in the retainer stops the rotation.
    4. Continue this process for all of the connectors for a panel.

5. Using the notches on the fiber composite connectors, the sufficient connectors to the structural reinforcing bars to hold the insulation in place. Alternately, the connectors can be pre-installed, and the insulation system can be pre-wired to the reinforcing cage before installation in the form.

B. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in passing through concrete work.

B. Locate and set in place items that will be cast directly into concrete.

C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.

D. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.

E. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement.

3.06 FORM CLEANING

A. Clean forms as erection proceeds, to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
2. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.07 FORMWORK TOLERANCES

A. Construct formwork to maintain tolerances required by ACI SPEC-117, unless otherwise indicated.

B. Camber slabs and beams in accordance with ACI SPEC-301.

3.08 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.

B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.

3.09 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

D. Remove and replace cast-in-place architectural concrete that cannot be repaired to Architect's approval.

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 018113.14 – Sustainable Design Requirements – HPBS.

B. Section 031000 - Concrete Forming and Accessories.

C. Section 033000 - Cast-in-Place Concrete.

D. Section 042613 - Masonry Veneer: Spacing for veneer anchor reglets recessed in concrete.

1.03 REFERENCE STANDARDS

A. ACI MNL-66 - ACI Detailing Manual; 2020.

B. ACI SPEC-301 - Specifications for Concrete Construction; 2020.

C. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.

D. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.

E. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021, with Errata (2023).

F. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars; 2018, with Amendment (2020).

G. CRSI (DA4) - Manual of Standard Practice; 2023.

1.04 SUBMITTALS

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

B. Sustainable Design Submittals: Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC liquid floor treatments and curing and sealing compounds.

C. Shop Drawings: Comply with requirements of ACI MNL-66 Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.

D. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.

E. 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.

1.05 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI SPEC-301.

1. Maintain one copy of each document on project site.

B. 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).

B. Steel Welded Wire Reinforcement (WWR): Galvanized, deformed type; ASTM A1064/A1064M.

1. Form: Flat Sheets.
2. WWR Style: 4 x 8-W6 x W10.

C. Reinforcement Accessories:

1. Tie Wire: Annealed, minimum 16 gauge, 0.0508 inch.

2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.

2.02 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.

C. Locate reinforcing splices not indicated on drawings at point of minimum stress.

1. Review locations of splices with Architect.

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. Comply with applicable code for concrete cover over reinforcement.

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 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. Concrete foundation walls and footings.

C. Joint devices associated with concrete work.

D. Concrete curing.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 031000 - Concrete Forming and Accessories: Forms and accessories for formwork.

C. Section 032000 - Concrete Reinforcing.

D. Section 079200 - Joint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.

1.03 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.

1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.

C. Mix Design: Submit proposed concrete mix design.

D. Samples: Submit samples of underslab vapor retarder to be used.

E. Test Reports: Submit report for each test or series of tests specified.

F. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.

G. Sustainable Design Submittals Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC liquid floor treatments and curing and sealing compounds.

H. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.04 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI SPEC-301 and ACI CODE-318.

B. Follow recommendations of ACI PRC-306 when concreting during cold weather.

PART 2 PRODUCTS

2.01 FORMWORK

A. Comply with requirements of Section 031000.

2.02 REINFORCEMENT MATERIALS

A. Comply with requirements of Section 032000.

2.03 CONCRETE MATERIALS

A. Normal Blended Hydraulic Cement: Type IL.

B. Fine and Coarse Aggregates: ASTM C33/C33M.

C. Fly Ash: ASTM C618, Class C or F.

D. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.04 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.

2.05 ACCESSORY MATERIALS

A. Underslab Vapor Retarder:

1. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.

2.06 BONDING AND JOINTING PRODUCTS

A. Slab Isolation Joint Filler: 1/2-inch thick, height equal to slab thickness, with removable top section forming 1/2-inch deep sealant pocket after removal.

B. Slab Contraction Joint Device: Preformed linear strip intended for pressing into wet concrete to provide straight route for shrinkage cracking.

2.07 CONCRETE MIX DESIGN

A. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended or required by manufacturer.

2.08 MIXING

A. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 EXECUTION

3.01 EXAMINATION

3.02 PREPARATION

A. Verify that forms are clean and free of rust before applying release agent.

B. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

C. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

3.03 PLACING CONCRETE

A. Place concrete in accordance with ACI PRC-304.

B. Place concrete for floor slabs in accordance with ACI PRC-302.1.

C. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

D. Ensure reinforcement, inserts, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.

E. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.

F. 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. Contraction Joint Devices: Use preformed joint device, with top set flush with top of slab.

3.05 FLOOR FLATNESS AND LEVELNESS TOLERANCES

A. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:

1. Exposed to View and Foot Traffic: F(F) of 20; F(L) of 15, on-grade only.
2. Under Thick-Bed Tile: F(F) of 20; F(L) of 15, on-grade only.
3. Under Carpeting: F(F) of 25; F(L) of 20, on-grade only.
4. Under Thin Resilient Flooring and Thinset Tile: F(F) of 35; F(L) of 25, on-grade only.

B. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155 (ASTM E1155M), within 48 hours after slab installation; report both composite overall values and local values for each measured section.

C. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 13/F(L) 10.

D. 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. Repair surface defects, including tie holes, immediately after removing formwork.

B. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:

C. Concrete Slabs: Finish to requirements of ACI PRC-302.1 and as follows:

1. Other Surfaces to Be Left Exposed: Trowel as described in ACI PRC-302.1, minimizing burnish marks and other appearance defects.

3.07 CURING AND PROTECTION

A. Comply with requirements of ACI PRC-308. 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. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
2. 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.

3. 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. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cubic yards or less of each class of concrete placed.

D. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

3.09 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.

B. 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.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.10 PROTECTION

A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION 033000

SECTION 033511 - CONCRETE FLOOR FINISHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface treatments for concrete floors and slabs.

B. Clear penetrating sealers, verify compatible with finish flooring products and materials.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

B. Section 033000 - Cast-in-Place Concrete: Finishing of concrete surface to tolerance; floating, troweling, and similar operations; curing.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with concrete floor placement and concrete floor curing.

1.04 SUBMITTALS

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

B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.

C. Product Data: Manufacturer's published data and installation instructions for concrete polishing system and finishing products, including manufacturer's installation instructions, information on compatibility of different products, and limitations.

D. Sustainable Design Submittals: Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC liquid floor treatments and curing and sealing compounds.

E. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

F. Specimen Warranty: Manufacturer warranty.

1.05 QUALITY ASSURANCE

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's sealed packaging, including application instructions.

1.07 FIELD CONDITIONS

A. Maintain light level equivalent to a minimum 200 W light source at 8 feet above the floor surface over each 20 foot square area of floor being finished.

B. Do not finish floors until interior heating system is operational.

C. Maintain ambient temperature of 50 degrees F minimum.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective work within a two-year period commencing on the Date of Substantial Completion.

C. Finish Warranty: Provide five-year manufacturer warranty against excessive degradation of finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 CONCRETE FLOOR FINISH APPLICATIONS

A. Unless otherwise indicated, all concrete floors are to be finished using liquid densifier/hardener.

B. Penetrating Clear Sealer:

1. Use at following locations: As noted in the drawings.

2.02 DENSIFIERS AND HARDENERS

A. Liquid Densifier and Hardener: Penetrating chemical compound that reacts with concrete, filling the pores, hardening, and dustproofing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that floor surfaces are acceptable to receive the work of this section.

B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.02 GENERAL

A. Apply materials in accordance with manufacturer's instructions.

3.03 COATING APPLICATION

A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.

B. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.

C. Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

END OF SECTION 033511

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SECTION 042613 - MASONRY VENEER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clay facing brick.

B. Mortar and grout.

C. Reinforcement and anchorage.

D. Flashings.

E. Installation of lintels.

F. Accessories.

1.02 RELATED REQUIREMENTS

A. 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 054000 - Cold-Formed Metal Framing: Steel stud backup for masonry veneer.

C. Section 055000 - Metal Fabrications: Loose steel lintels.

D. Section 076200 - Sheet Metal Flashing and Trim.

E. Section 079200 - Joint Sealants: Sealing control and expansion joints.

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.

B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and mortar.

C. Sustainable Design Submittals: Include:

a. Sustainable design requirements for recycled content.

b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC liquid treatments and sealing compounds.

D. Samples: Submit four samples of decorative block units to illustrate color, texture, and extremes of color range.

E. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.

B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.

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

1.06 MOCK-UP

A. Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar and accessories and structural backup in mock-up.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

B. Handle and store ceramic glazed masonry units in protective cartons or trays. Do not remove from protective packaging until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.

B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 BRICK UNITS

A. Manufacturers:

1. Endicott Clay Products Co; Face Brick: www.endicott.com/#sle.
2. Interstate Brick; .

B. Facing Brick: ASTM C216, Type As noted below, Grade As noted below.

1. Color and Texture: Ash.

a. TX1: Type FBS Rough, Grade SW
b. TX2: Type FBS Scratch , Grade SW
c. TX3: Type FBS Matte , Grade SW

2. Nominal Size: 4 x 4 x 16 inches.
3. Compressive Strength: As indicated on drawings, measured in accordance with ASTM C67/C67M.

2.02 MORTAR AND GROUT MATERIALS

A. Masonry Cement: ASTM C91/C91M Type N.

1. Colored Mortar: Premixed cement as required to match Architect's color sample.
2. Basis-Of-Design Product: Spec Mix, LLC; SM300 - Light Buff.
3. Substitutions: See Section 016000 - Product Requirements.

B. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.

C. Hydrated Lime: ASTM C207, Type S.

D. Water: Clean and potable.

2.03 REINFORCEMENT AND ANCHORAGE

A. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.

1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
3. Vertical adjustment: Not less than 3-1/2 inches.

4. Seismic Feature: Provide lip, hook, or clip on end of wire ties to engage or enclose not less than one continuous horizontal joint reinforcement wire of 0.1483 inch diameter.

2.04 FLASHINGS

A. Metal Flashing Materials: Metallic-Coated Steel Sheet, as specified in Section 076200.

B. Combination Non-Asphaltic Flashing Materials - Stainless Steel:

1. Stainless Steel Flashing - Self-adhering: ASTM A240/A240M; 2 mil type 304 stainless steel sheet with 8 mil of butyl adhesive and a removable release liner.

a. Manufacturers:

1) 3GEN Masonry Products; GENFLASH SS SA: www.3genmp.com/#sle.
2) York Manufacturing, Inc; York 304: www.yorkmfg.com/#sle.
3) Substitutions: See Section 016000 - Product Requirements.

2.05 ACCESSORIES

A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.

B. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.

C. Weeps:

1. Type: Extruded propylene with honeycomb design.
2. Color(s): As selected by Architect from manufacturer's full range.
3. Manufacturers:

a. Blok-Lok Limited: www.blok-lok.com/#sle.
b. Hohmann & Barnard, Inc: www.h-b.com/#sle.
c. Mortar Net Solutions; WeepVent: www.mortarnet.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

D. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.

1. Mortar Diverter: Panels installed at flashing locations.

a. Manufacturers:

1) 3GEN Masonry Products; Wall Defender: www.3genmp.com/#sle.
2) Advanced Building Products, Inc; Mortar Break® DT
: www.advancedbuildingproducts.com/#sle.

3) Mortar Net Solutions; MortarNet: www.mortarnet.com/#sle.
4) Substitutions: See Section 016000 - Product Requirements.

E. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.06 MORTAR AND GROUT MIXING

A. Mortar for Unit Masonry: ASTM C270, Proportion Specification.

1. Exterior, non-loadbearing masonry; Type S.

PART 3 EXECUTION

3.01 EXAMINATION

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

B. Verify that related items provided under other sections are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Brick Units:

1. Bond: As indicated for different locations.
2. Coursing: Three units and three mortar joints to equal 8 inches.
3. Mortar Joints: Concave.

3.03 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.

B. Remove excess mortar as work progresses.

C. Interlock intersections and external corners, except for units laid in stack bond.

D. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

E. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.04 WEEPS/CAVITY VENTS

A. Install weeps in veneer walls at 24 inches on center horizontally on top of through-wall flashing above shelf angles and lintels and at bottom of walls.

3.05 CAVITY MORTAR CONTROL

A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.

B. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.

C. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.06 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

A. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 18 inches on center vertically and 16 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

B. Seismic Reinforcement: Connect veneer anchors with continuous horizontal wire reinforcement before embedding anchors in mortar.

3.07 MASONRY FLASHINGS

A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.

B. Terminate flashing up 8 inches minimum on vertical surface of backing:

C. Extend metal flashings through exterior face of masonry and terminate in an angled drip with hemmed edge. Install joint sealer below drip edge to prevent moisture migration under flashing.

3.08 LINTELS

A. Install loose steel lintels over openings.

B. Maintain minimum 8 inch bearing on each side of opening.

3.09 CONTROL AND EXPANSION JOINTS

A. Do not continue horizontal joint reinforcement through control or expansion joints.

B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

C. Size control joints as indicated on drawings; if not indicated, 3/4 inch wide and deep.

D. Form expansion joint as detailed on drawings.

3.10 TOLERANCES

A. Install masonry within the site tolerances found in TMS 402/602.

B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.

C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.

D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

E. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.

F. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.

3.11 CUTTING AND FITTING

A. Cut and fit for pipes and conduit. Coordinate with other sections of work to provide correct size, shape, and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.12 CLEANING

A. Remove excess mortar and mortar smears as work progresses.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

3.13 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION 042613

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Structural steel framing members.

B. Base plates, shear stud connectors and expansion joint plates.

C. Grouting under base plates.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

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

C. Section 055000 - Metal Fabrications: Steel fabrications affecting structural steel work.

1.03 SUBMITTALS

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

B. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, materials and adhesives.

C. Shop Drawings:

1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
2. Connections detailed.
3. Indicate cambers.
4. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.

D. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.

E. Mill Test Reports: Indicate structural strength, destructive test analysis and non-destructive test analysis.

F. Fabricator Test Reports: Comply with ASTM A1011/A1011M.

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.

J. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172 or AISC.

1.04 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. Fabricator: Company specializing in performing the work of this section with minimum 5 years of documented experience.

D. 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.

E. Erector: Company specializing in performing the work of this section with minimum 5 years of documented experience.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Angles and Channels: ASTM A36/A36M.

B. Steel W Shapes and Tees: ASTM A992/A992M.

C. Cold-Formed Structural Tubing: ASTM A500/A500M, Grade C.

D. Steel Plate: ASTM A36/A36M.

E. Shear Stud Connectors: Made from ASTM A108 Grade 1015 bars.

F. High-Strength Structural Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, with matching compatible ASTM A563/A563M nuts and ASTM F436/F436M washers.

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. 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.
2. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch.

J. Shop and Touch-Up Primer: Coordinate with Division 09 painting sections for primers compatible with finish coats and, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

A. Shop fabricate to greatest extent possible.

B. Space shear stud connectors at designed number of inches on center as per general structural notes.

C. Fabricate connections for bolt, nut, and washer connectors.

2.03 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.

2.04 SOURCE QUALITY CONTROL

A. Provide shop testing and analysis of structural steel.

B. High-Strength Bolts: Provide testing and verification of shop-bolted connections in accordance with RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts," testing at least 10 percent of bolts at each connection.

C. Welded Connections: Visually inspect all shop-welded connections and test at least 10 percent of welds using one of the following:

1. Radiographic testing performed in accordance with ASTM E94/E94M.
2. Ultrasonic testing performed in accordance with ASTM E164.
3. Liquid penetrant inspection performed in accordance with ASTM E165/E165M.
4. Magnetic particle inspection performed in accordance with ASTM E709.

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.

3.03 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

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 10 percent of bolts at each connection.

C. Welded Connections: Visually inspect all field-welded connections and test at least 10 percent of welds using one of the following:

1. Radiographic testing performed in accordance with ASTM E94/E94M.
2. Ultrasonic testing performed in accordance with ASTM E164.
3. Liquid penetrant inspection performed in accordance with ASTM E165/E165M.

4. Magnetic particle inspection performed in accordance with ASTM E709.

END OF SECTION 051200 051200

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SECTION 053100 - STEEL DECKING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof deck.

B. Supplementary framing for openings up to and including 18 inches.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 051200 - Structural Steel Framing: Placement of embedded steel anchors for bearing plates in cast-in-place concrete.

C. Section 055000 - Metal Fabrications: Steel angle concrete stops at deck edges.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittals procedures.

B. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, materials and adhesives.

D. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.

E. Certificates: Certify that products furnished meet or exceed specified requirements.

F. Submit manufacturer's installation instructions.

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: Provide documentation showing steel fabricator is accredited under IAS AC172.

1.04 QUALITY ASSURANCE

A. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M and dated no more than 12 months before start of scheduled welding work.

B. Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Cut plastic wrap to encourage ventilation.

B. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Steel Deck:

1. Cordeck, Inc: www.cordeck.com/#sle.
2. New Millennium Building Systems: www.newmill.com/#sle.
3. Nucor-Vulcraft Group: www.vulcraft.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 STEEL DECK

A. Roof Deck: Non-composite type, fluted steel sheet:

1. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 50/340, Class 1, 2, or 4, with G60/Z180 galvanized coating.
2. Minimum Base Metal Thickness: 20 gauge, 0.0359 inch. for roof deck and 16 gauge, 0.0635 inch for dumpster enclosure gate.
3. Nominal Height: 3 inch.
4. Profile: Fluted; SDI N.
5. Formed Sheet Width: 32 inch.
6. Side Joints: Lapped, mechanically fastened.
7. End Joints: Lapped, mechanically fastened.

2.03 ACCESSORY MATERIALS

A. Fasteners: Galvanized hardened steel, self tapping.

B. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, complying with VOC limitations of authorities having jurisdiction.

C. Flute Closures: Closed cell foam rubber, 1 inch thick; profiled to fit tight to the deck.

2.04 FABRICATED DECK ACCESSORIES

A. Sheet Metal Deck Accessories: Metal closure strips, wet concrete stops, and cover plates, 22 gauge, 0.0299 inch thick sheet steel; of profile and size as indicated; finished same as deck.

B. Roof Sump Pans: Formed sheet steel, 14 gauge, 0.0747 inch minimum thickness, flat bottom, sloped sides, recessed 1-1/2 inches below roof deck surface, bearing flange 3 inches wide, sealed watertight.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions prior to beginning work.

3.02 INSTALLATION

A. Erect metal deck in accordance with SDI Design Manual and manufacturer's instructions. Align and level.

B. Fasten deck to steel support members at ends and intermediate supports at 12 inches on center maximum, parallel with the deck flute and at each transverse flute using methods specified.

C. At mechanically fastened male/female side laps fasten at 24 inches on center maximum.

D. Weld deck in accordance with AWS D1.3/D1.3M.

E. Close openings above walls and partitions perpendicular to deck flutes with single row of foam cell closures.

F. Position roof drain pans with flange bearing on top surface of deck. Fusion weld at each deck flute.

G. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up primer.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Formed steel stud exterior wall framing.

B. Exterior wall sheathing.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 042613 - Masonry Veneer: Veneer masonry supported by wall stud metal framing.

C. Section 053100 - Steel Decking.

D. Section 092116 - Gypsum Board Assemblies: Cold-formed steel nonstructural framing.

E. Section 092116 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.03 DEFINITIONS

A. Connection: A combination of structural elements and joints used to transmit forces between two or more members.

B. Connector: A device used to transmit forces between cold-formed steel structural members or between a cold-formed steel structural member and another structural element.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with work of other sections that is to be installed in or adjacent to metal framing systems, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by affected installers.

1.05 SUBMITTALS

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

B. Product Data: Provide data on cold-formed steel structural members; include material descriptions and base steel thickness.

C. Product Data: Provide manufacturer's data on factory-made connectors and mechanical fasteners, showing compliance with requirements.

D. Product Data: For lateral-force resisting systems, provide product data sheets on hold-down, showing compliance with requirements.

E. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. coatings, materials and adhesives.

F. 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. Indicate stud layout.

2. Describe method for securing studs to tracks and for bolted framing connections.

G. Design Data:

1. Shop drawings signed and sealed by a professional structural engineer.
2. Design calculations sufficient to demonstrate compliance with design criteria; signed and sealed by a professional structural engineer.
3. Details and calculations for factory-made connectors, signed and sealed by a professional structural engineer.

H. Evaluation Service Reports: Provide reports indicating compliance with specified requirements for cold-formed steel structural members.

I. Inspection Reports: Provide material verification Inspection Reports in accordance with requirements of AISI S240.

J. Inspection Reports: Provide Inspection Reports for welding, mechanical fastening, cold-formed steel light-frame construction, and lateral force-resisting systems in accordance with requirements of AISI S240.

K. Installation Drawings: Indicate dimensioned locations of cold-formed steel structural framing.

1. Include materials.

L. Manufacturer's Qualification statement.

M. Testing Agency Qualification Statement.

N. Testing Agency Qualification statement.

1.06 QUALITY ASSURANCE

A. See Section 014000 - Quality Requirements for additional requirements.

B. Designer Qualifications: Design framing system under direct supervision of a professional structural engineer experienced in designing this work and licensed in the State in which the Project is located.

C. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.

D. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.

E. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

1.07 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional requirements.

B. Provide mock-up of exterior framed wall, including components specified elsewhere, such as insulation, sheathing, window frame, door frame, exterior wall finish, and interior wall finish.

C. Locate where directed.

D. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Structural Framing:

1. CEMCO: www.cemcosteel.com/#sle.
2. ClarkDietrich: www.clarkdietrich.com/#sle.
3. MarinoWARE: www.marinoware.com/#sle.
4. SCAFCO Corporation: www.scafco.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Connectors:

1. Same manufacturer as metal framing.

2.02 PERFORMANCE REQUIREMENTS

A. Design Requirements: Design cold-formed framing systems, components and connectors to withstand specified design loads in compliance with ICC (IBC), ASCE 7, AISI S100, and AISI S240.

B. Design Criteria: As indicated on the drawings.

1. Live load deflection meeting the following, unless otherwise indicated:

a. Roofs: Maximum vertical deflection under live load of 1/240 of span.

2. Seismic Criteria: Comply with ASCE 7 and with local authorities having jurisdiction:

a. Site Class: As indicated in General Structural Notes.
b. Seismic Design Category: As indicated in General Structural Notes.
c. Seismic Importance Factor: As indicated in General Structural Notes.

3. 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.

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

C. Fabrication:

1. Shop-fabricate cold-formed framing systems and connectors to the greatest extent possible.

2.03 MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.

1. Structural Grade: As required to meet design criteria.
2. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.04 STRUCTURAL FRAMING COMPONENTS

A. Wall Studs and Track Sections: AISI S240; c-shaped studs and u-shaped track sections in stud-matching nominal width and compatible height.

1. Thickness and Depth: Depth as indicated on the drawings; thickness and structural grade as required to meet design criteria.

2. Provide components fabricated from ASTM A1011/A1011M Designation SS (structural steel).

B. Headers: AISI S240; manufactured, engineered one-member or two-member assemblies, with wide flanges, designed to replace conventional box or nested header framing at openings.

1. Structural Grade: As required to meet design criteria.
2. Corrosion Protection Coating Designation: CP 60 in accordance with AISI S240.
3. Thickness and Depth: As indicated on drawings.
4. Jamb Mounting Clips: Manufacturer's standard.

2.05 CONNECTIONS

A. Structural Performance: Maintain load and movement capacity required by applicable building code and specified design criteria.

B. Movement Connections: Provide mechanical anchorage devices that accommodate movement using slotted holes, shouldered screws or screws and anti-friction or stepped bushings, while maintaining structural performance of framing. Provide movement connections where indicated on drawings.

1. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 10 feet.

C. Bridging Connections: Provide mechanical load-transferring devices that accommodate wind load torsion and weak axis buckling induced by axial compression loads. Provide bridging connectors where indicated on the drawings.

D. Products:

1. ClarkDietrich; Spazzer 5400 Bridging Bar: www.clarkdietrich.com/#sle.
2. Simpson Strong-Tie; SUBH Bridging Connector: www.strongtie.com/#sle.
3. Substitutions: See Section 016000 - Product Requirements.

2.06 MISCELLANEOUS CONNECTIONS

A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot-dip galvanized per ASTM A153/A153M.

B. Anchorage Devices: Powder actuated.

2.07 SHEATHING

A. Gypsum Board Wall Sheathing: See Section 092116.

2.08 ACCESSORIES

A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.

B. Galvanizing Repair: Touch up bare steel with zinc-rich paint in compliance with ASTM A780/A780M.

C. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify field measurements and adjust installation as required.

3.02 PREPARATION

A. Structural Wall Foundations: For gaps between wall bottom track and top of foundation 1/4 inch or greater, level substrate with loadbearing shims or grout between track and foundation.

3.03 INSTALLATION - GENERAL

A. Install structural members and connections in compliance with ASTM C1007.

3.04 INSTALLATION OF STUDS

A. Install wall studs plumb and level.

B. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.

C. Install load-bearing studs full length in one piece. Splicing of studs is not permitted.

D. Install load-bearing studs; brace, and reinforce to develop full strength and achieve design requirements.

E. Install intermediate studs above and below openings to align with wall stud spacing.

F. Provide deflection allowance in stud track, directly below horizontal building framing at non-loadbearing framing.

G. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.

3.05 INSTALLATION OF WALL SHEATHING

A. Install wall sheathing with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.

1. Provide steel diagonal bracing at corners with foam insulation or gypsum board wall sheathing.

3.06 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Provide material verification inspections in accordance with requirements of AISI S240.

C. Provide inspections for welding, mechanical fastening, and cold-formed steel light-frame construction in accordance with requirements of AISI S240.

3.07 TOLERANCES

A. Studs - Vertical Alignment (Plumbness): 1/960 of span or 1/8 inch in 10 ft, in accordance with ASTM C1007.

B. Studs - Maximum Variation from True Position: 1/8 inch in accordance with ASTM C1007.

C. Stud Spacing: 1/8 inch from the designated spacing, provided that the cumulative error does not exceed the requirements of the finishing materials in accordance with ASTM C1007.

END OF SECTION 054000

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577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 055000 - METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Shop fabricated steel and aluminum items.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 042613 - Masonry Veneer: Placement of metal fabrications in masonry.

C. Section 053100 - Steel Decking: Bearing plates for metal deck bearing, including anchorage.

D. Section 055133 - Metal Ladders.

E. Section 099113 - Exterior Painting: Paint finish.

F. Section 099123 - Interior Painting: Paint finish.

G. Section 099600 - High Performance Coatings: Paint Finish

1.03 SUBMITTALS

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

B. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. coatings, materials and adhesives.

C. 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. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
2. Design data: Submit drawings and supporting calculations, signed and sealed by a qualified professional structural engineer.

a. Include the following, as applicable:

1) Member sizes and gauges.
2) Details of connections.
3) Support reactions.
4) Bracing 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. Designer's Qualification Statement.

F. Sustainable Design Submittals:

1. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2. Environmental Product Declaration: For each product.

1.04 QUALITY ASSURANCE

A. Design structural support items under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.

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. Slotted Channel Fittings: ASTM A1011/A1011M.

F. Bolts, Nuts, and Washers: ASTM A307, Grade A, plain.

G. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.02 MATERIALS - ALUMINUM

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.

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 FABRICATED ITEMS

A. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.

B. Ledge Angles, Shelf Angles, Channels, and Plates Not Attached to Structural Framing: For support of metal decking; prime paint finish.

C. Lintels: As detailed; prime paint finish.

D. Door Frames for Overhead Door Openings, Wall Openings, and supports: Channel sections; prime paint finish.

E. Slotted Channel Framing: Fabricate channels and fittings from structural steel complying with the referenced standards; factory-applied, rust-inhibiting thermoset acrylic enamel finish.

F. Low Partition Framing Support: 3/8-inch ASTM A36/A36M steel-plate ST50H stud connector designed to support out-of-plane loading of cantilevered partial wall systems that are unsupported at the top track.

1. Basis-of-Design Product: Subject to compliance with requirements, provide ClarkDietrich; Pony Wall LGPW60 or comparable product by one of the following:

a. The Steel Network; MidWall
b. SCAFCO Steel Stud Company; PonyWall
c. Substitutions: See Section016000-Product Requirements.

2.05 FINISHES - STEEL

A. Prime paint steel items.

1. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.

B. Prepare surfaces to be primed in accordance with SSPC-SP2.

C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

D. Prime Painting: One coat; compatible with Division 09 finish coats.

E. Slotted Channel Framing: ASTM A653/A653M, Grade 33.

2.06 FINISHES - ALUMINUM

A. Exterior Aluminum Surfaces: Class I color anodized.

2.07 FABRICATION TOLERANCES

A. Squareness: 1/8 inch maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16 inch.

C. Maximum Misalignment of Adjacent Members: 1/16 inch.

D. Maximum Bow: 1/8 inch in 48 inches.

E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

3.03 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. Field weld components as indicated on drawings.

D. Perform field welding in accordance with AWS D1.1/D1.1M.

E. Obtain approval prior to site cutting or making adjustments not scheduled.

F. After erection, prime welds, abrasions, and surfaces not shop primed , except surfaces to be in contact with concrete.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 055000

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SECTION 055133 - METAL LADDERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Shop-fabricated metal ladders.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 099600 - High-Performance Coatings: Pain Finish

1.03 SUBMITTALS

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

B. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. coatings, materials and adhesives.

C.

D. 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.

E. Designer's Qualification Statement.

F. Sustainable Design Submittals:

1. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2. Health Product Declaration: For each product.
3. Environmental Product Declaration: For each product.

1.04 QUALITY ASSURANCE

A. Design ladder and mounting brackets under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.

B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M and dated no more than 12 months before start of scheduled welding work.

C. Fabricator Qualifications: A qualified steel fabricator that is accredited by IAS AC172.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

A. Steel Sections: ASTM A36/A36M.

B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.

C. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.

D. Mechanical Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.

E. Bolts, Nuts, and Washers: ASTM A307, plain.

F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

G. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

H. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, 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 FINISHES - STEEL

A. Prime paint steel items.

1. Do not prime surfaces in direct contact with concrete.
2. Do not prime surfaces where field welding is required.

B. Prepare surfaces to be primed in accordance with SSPC-SP2.

C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

D. Prime Painting: One coat.

E. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating.

2.04 FABRICATION TOLERANCES

A. Squareness: 1/8 inch maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16 inch.

C. Maximum Misalignment of Adjacent Members: 1/16 inch.

D. Maximum Bow: 1/8 inch in 48 inches.

E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

3.03 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. Perform field welding in accordance with AWS D1.1/D1.1M.

D. Obtain approval prior to site cutting or making adjustments not scheduled.

E. After erection, prime welds, abrasions, and surfaces not shop primed , except surfaces to be in contact with concrete.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 055133

SECTION 057500 - DECORATIVE FORMED METAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior fabrications made of formed metal sheet, secondary supports, and anchors to structure, including:

1. Closures, trim, and filler panels.
2. Metal base.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 099123 - Interior Painting.

C. Section 099600 – High performance Coatings.

1.03 SUBMITTALS

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

B. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

C. Shop Drawings: Show layout and elevations, dimensions and thickness of panels, connections, details and location of joints, sealants and gaskets, method of anchorage, number of anchors, supports, reinforcement, trim, flashings, and accessories.

1. Differentiate between shop and field fabrication.
2. Indicate substrates and adjacent work with which the fabrications must be coordinated.
3. Include large-scale details of anchorages and connecting elements.

4. Include large-scale details or schematic, exploded or isometric diagrams to fully explain flashing at a scale of not less than 1/4 inches per 12 inches.

D. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.

E. Certificate: Certify that work results of this section meet or exceed specified requirements.

F. Installer's Qualification Statement.

G. Maintenance Data: Care of finishes and warranty requirements.

H. Executed Warranty: Submit warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating products specified in this section.

1. With not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified in this section.

1. With minimum 3 years of documented experience.

2. Approved by fabricator.

C. Mock-Up: Provide a mock-up for evaluation of fabrication workmanship.

1. Locate where directed.
2. Provide products finished as specified.
3. Mock-up may remain as part of the Work if approved by the architect.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original, unopened, undamaged containers with identification labels intact.

1. Protect finishes by applying heavy duty removable plastic film during production.
2. Package for protection against transportation damage.
3. Provide markings to identify components consistently with drawings.
4. Exercise care in unloading, storing and installing panels to prevent bending, warping, twisting and surface damage.

B. Store products protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

1. Store in well-ventilated space out of direct sunlight.

2. Protect from moisture and condensation with tarpaulins or other suitable weathertight covering installed to provide ventilation.
3. Store at a slope to ensure positive drainage of accumulated water.
4. Do not store in enclosed space where ambient temperature can exceed 120 degrees F.
5. Avoid contact with other materials that might cause staining, denting, or other surface damage.

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Product: As indicated on drawings or approved substitution.

2.02 FORMED METAL FABRICATIONS - GENERAL

A. Shop Assembly: Preassemble items to greatest extent possible. Minimize field splices and field assembly. Disassemble only as necessary for transportation and handling. Mark items clearly for assembly and installation.

B. Coordination: Match dimensions and attachment of formed metal items to adjacent construction. Produce integrated assemblies. Closely fit joints; align edges and flat surfaces unless indicated otherwise.

C. Forming: Profiles indicated. Maximize lengths. Fold exposed edges to form hem indicated or ease edges to radius indicated with concealed stiffener. Provide flat, flush surfaces without cracking or grain separation at bends.

D. Reinforcement: Increase metal thickness; use concealed stiffeners, backing materials or both. Provide stretcher leveled standard of flatness and stiffness required to maintain flatness and hold adjacent items in flush alignment.

E. Anchors: Straps, plates and anchors as required to support and anchor items to adjacent construction.

F. Supports: Miscellaneous framing, mounting, clips, sleeves, fasteners and accessories required for installation.

G. Welding and Brazing: Weld or braze joints continuously. Grind, fill or dress to produce smooth, flush, exposed surfaces. Do not discolor metal. Grind smooth, polish, and restore damaged finishes to required condition.

2.03 MATERIALS

A. General: Provide sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections exposed to view on finished units.

B. Aluminum Sheet: ASTM B209/B209M, 5005-H32 minimum; alloy and temper recommended by aluminum producer and finisher for use and finish indicated.

C. Fasteners, General: Same basic metal and alloy as formed metal sheet unless indicated otherwise. Do not use metals incompatible with the materials joined.

D. Joint Sealer, Interior: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C834; of type and grade required to seal joints in decorative formed metal; as recommended in writing by decorative formed metal manufacturer and with a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Laminating Adhesive: Recommended by metal fabricator; fully bond metal to metal, prevent telegraphing and oil canning; compatible with substrate; noncombustible after curing. VOC contents calculated according to 40 CFR 59, Subpart D (EPA Method 24) listed below.

1. Contact Adhesive: 80 g/L or less.

2. Multipurpose Construction Adhesive: 70 g/L or less.

3. Adhesive shall comply with the testing and product requirements of CAL (CDPH SM).

2.04 PAINTS AND COATINGS

A. As specified in Section 099123.

2.05 FINISHES

A. Finishes, General: Comply with NAAMM AMP 500-06.

1. Complete mechanical finishes before fabrication. After fabrication, finish joints, bends, abrasions and surface blemishes to match sheet.
2. Protect mechanical finishes on exposed surfaces from damage.
3. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
4. Appearance: Limit variations in appearance of adjacent pieces to one-half of range represented in approved samples. Noticeable variations in same piece are not acceptable. Install components within range of approved samples to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and interfaces with other work.

B. Verify substrate on-site to determine that conditions are acceptable for product installation in accordance with manufacturer's written instructions.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Notify Architect in writing of conditions detrimental to proper and timely completion of work. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protect adjacent work areas and finish surfaces from damage during installation.

3.03 INSTALLATION - SHEET METAL AND PLATE FABRICATIONS

A. Locate and place decorative formed sheet metal items level and plumb; align with adjacent construction. Cut, drill and fit as required to install.

B. Do not cut or abrade sheet metal finishes that cannot be completely restored in the field. Return such items to manufacturer or fabricator for required alterations and refinishing or provide new items.

C. Use concealed anchorages where possible. Provide washers where needed on bolts or screws to protect metal surfaces and make weathertight connection.

D. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers indicated.

E. Corrosion Protection: Apply permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with incompatible substrate materials. Prevent corrosion damage to material and finish.

3.04 CLEANING

A. Restore finishes damaged during installation and construction period. Return items that cannot be refinished in the field to manufacturer or fabricator. Refinish entire unit or provide new units.

B. Remove protective film after installation of joint sealers, after cleaning of adjacent materials, and immediately prior to completion of work.

C. Remove temporary coverings and protection of adjacent work areas.

D. Clean installed products in accordance with manufacturer's instructions.

3.05 PROTECTION

A. Protect installed products from damage during construction.

END OF SECTION 057500

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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. Communications and electrical room mounting boards.

D. Concealed wood blocking, nailers, and supports.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 018113 .14 – Sustainable Design Requirements – HPBS.

C. Section 092116 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.03 SUBMITTALS

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

B. Product Data: Provide technical data on wood preservative materials and application instructions.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, materials and adhesives.

1.04 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective work within a two-year period commencing on Date of Substantial Completion.

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.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

A. Sizes: Nominal sizes as indicated on drawings, S4S.

B. Moisture Content: S-dry or MC19.

C. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:

1. Lumber: S4S, No.2 or Standard Grade.
2. Boards: Standard or No.3.

2.03 CONSTRUCTION PANELS

A. Communications and Electrical Room Mounting Boards: PS 1, A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.04 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.

2.05 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA 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 AWPA standards.

B. Fire Retardant Treatment:

1. Exterior Type: AWPA U1, Category UCFB, Commodity Specification H, 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 both before and after accelerated weathering test performed in accordance with ASTM D2898.

a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
b. Do not use treated wood in direct contact with ground.

2. Interior Type A: AWPA 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: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.10 lb/cu ft retention.

a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.

2. Preservative Pressure Treatment of Plywood Above Grade: AWPA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative to 0.25 lb/cu ft retention.

a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate installation of rough carpentry members specified in other sections.

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. Provide the following specific nonstructural framing and blocking:

1. Grab bars.
2. Towel and bath accessories.
3. Chalkboards and marker boards.

3.04 INSTALLATION OF CONSTRUCTION PANELS

A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on edges and into studs in field of board.

1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
3. Install adjacent boards without gaps.

3.05 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 064100 - ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Specially fabricated cabinet units.

B. Hardware.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 018113 .14 – Sustainable Design Requirements – HPBS.

C. Section 061000 - Rough Carpentry: Support framing, grounds, and concealed blocking.

D. Section 123600 - Countertops.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

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

B. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants, materials and adhesives.

C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.

1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

D. Product Data: Provide data for hardware accessories.

E. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.

F. Samples: Submit actual sample items of proposed pulls, hinges, shelf standards, and locksets, demonstrating hardware design, quality, and finish.

1.05 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
2. Single Source Responsibility: Provide and install this work from single fabricator.

B. 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.
6. Replace, repair, or rework all work for which certification is refused.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect units from moisture damage.

1.07 FIELD CONDITIONS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

B. Plastic Laminate Faced Cabinets: Custom grade.

C. Cabinets:

1. Finish - Exposed Exterior Surfaces: Decorative laminate.
2. Finish - Exposed Interior Surfaces: Decorative laminate.
3. Finish - Semi-Exposed Surfaces: Decorative laminate
4. Finish - Concealed Surfaces: Manufacturer's option.
5. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
6. Door and Drawer Front Retention Profiles: Fixed panel.
7. Casework Construction Type: Type A - Frameless.
8. Interface Style for Cabinet and Door: Style 1 - Overlay; flush overlay.
9. Grained Face Layout for Cabinet and Door Fronts: Flush panel.

    a. Custom Grade: Doors, drawer fronts and false fronts wood grain to run and match vertically within each cabinet unit.

10. Adjustable Shelf Loading: 40 psf.
11. Cabinet Style: Flush overlay.
12. Cabinet Doors and Drawer Fronts: Flush style.
13. Drawer Side Construction: Multiple-dovetailed.
14. Drawer Construction Technique: Dovetail joints.

2.02 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

B. Provide sustainably harvested wood, certified or labeled; see Section 016000.

C. Wood fabricated from timber recovered from riverbeds or otherwise abandoned is permitted, unless otherwise noted, provided it is clean and free of contamination; identify source; provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc.

2.03 PANEL CORE MATERIALS

A. Medium Density Fiberboard (MDF): Composite panel composed of cellulosic fibers, additives, and bonding system; cured under heat and pressure; comply with ANSI A208.2.

1. Grade: 130; moisture resistance: MR10.
2. Panel Thickness: 3/4 inch.

2.04 THERMALLY FUSED LAMINATE PANELS

A. Thermally Fused Laminate (TFL): Melamine- or polyester-resin-saturated decorative papers; for fusion to composite wood substrates under heat and pressure.

1. Test in accordance with NEMA LD 3 Section 3.
2. Panel Core Substrate: Medium Density Fiberboard (MDF).

2.05 LAMINATE MATERIALS

A. Manufacturers:

1. Basis-of-Design as indicated on drawings.
2. Substitutions: See Section 016000 - Product Requirements.

B. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.

C. Provide specific types as follows:

1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, through color, colors as indicated, finish as indicated.
2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, through color, colors as indicated, finish as indicated.
3. Cabinet Liner: CLS, 0.020 inch nominal thickness, through color, colors as indicated, finish as indicated.
4. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.06 COUNTERTOPS

A. Countertops: See Section 123600.

2.07 ACCESSORIES

A. Adhesive: Type recommended by fabricator to suit application.

B. Plastic Edge Banding: Extruded PVC, flat shaped; smooth finish; self locking serrated tongue; of width to match component thickness.

1. Color: As selected by Architect from manufacturer's full range.
2. Use at all exposed plywood edges.
3. Use at all exposed shelf edges.

C. Fasteners: Size and type to suit application.

D. Concealed Joint Fasteners: Threaded steel.

E. Grommets: Standard plastic grommets for cut-outs, in color to match adjacent surface, and as required, coordinate with architect for locations and quantities.

2.08 HARDWARE

A. Cabinet Hardware: Comply with BHMA A156.9 for hardware types and grades indicated below:

1. Hardware Types: As indicated on drawings.
2. Product Grade: Grade 2.

B. Metal Z-Shaped Wall Cabinet Support Clips: Paired, cleated, structural anchorage components applied to back of cabinets and walls for wall cabinet mounting.

1. Material: Extruded Aluminum.
2. Thickness: 0.115 inch.
3. Height: 1.25 inch.
4. Stand-Off: 0.240 inch.
5. Lift-Off: 0.375 inch.
6. Width: 48 inches.
7. Products:

a. Eagle Aluminum; Eagle Z-Clips: www.eagle-aluminum.com/#sle.
b. Monarch Metal, Inc.; MF375: www.monarchmetal.com.
c. Mockett; ZC3-94 - Z Clips: www.mockett.com.
d. Substitutions: See Section 016000 - Product Requirements.

C. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.

D. Countertop Support Brackets: Fixed, L-shaped, face-of-stud mounting.

1. Materials: Steel; T-shape cross-section.

a. Finish: Manufacturer's standard, factory-applied, powder coat.
b. Color: Black.
c. Height: 18 inches.

2. Products:

a. A&M Hardware, Inc; Heavy-Duty Hybrid Brackets: www.aandmhardware.com/#sle.
b. Rakks/Rangine Corporation; EH Series Brackets: www.rakks.com/#sle.
c. Rakks/Rangine Corporation; EH-1230PS with EH Supported Pole: www.rakks.com/#sle.
d. Substitutions: See Section 016000 - Product Requirements.

E. Drawer and Door Pulls: Basis-of-Design as indicated on drawings.

F. Keyed Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with satin finish.

G. Drawer Slides:

1. Type: Full extension.
2. Static Load Capacity: Commercial grade.
3. Mounting: Side mounted.
4. Stops: Integral type.
5. Features: Provide self closing/stay closed type.
6. Manufacturers:

    a. Accuride International, Inc; Heavy-Duty Drawer Slides: www.accuride.com/#sle.
    b. Blum, Inc; TANDEM: www.blum.com/#sle.
    c. Knape & Vogt Manufacturing Company; Heavy-Duty Drawer Slides: www.knapeandvogt.com/#sle.
    d. Substitutions: See Section 016000 - Product Requirements.

H. Soft-Close, Door and Drawer Adjustable Dampers:

1. Manufacturers:

    a. Grass America Inc; Unisoft: www.grassusa.com/#sle.
    b. Titus Cabinet Hardware; Titusoft Dampers for Drawers: www.titusplus.com/us/en/#sle.
    c. Substitutions: See Section 016000 - Product Requirements.

I. Hinges: European style concealed self-closing type, steel with nickel-plated finish.

1. Manufacturers:

    a. Blum, Inc; CLIP top BLUMOTION: www.blum.com/#sle.
    b. Grass America Inc; Nexis: www.grassusa.com/#sle.
    c. Hettich America, LP; Intermat: www.hettich.com/#sle.
    d. Titus Cabinet Hardware; T-Type Concealed Hinge: www.titusplus.com/us/en/#sle.
    e. Substitutions: See Section 016000 - Product Requirements.

2.09 FABRICATION

A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.

C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.

1. Cap exposed plastic laminate finish edges with material of same finish and pattern.

E. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION

A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.

B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

C. Use fixture attachments in concealed locations for wall mounted components.

D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.

E. Secure cabinets to floor using appropriate angles and anchorages.

F. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 ADJUSTING

A. Adjust installed work.

B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 064100

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SECTION 064200 - WOOD PANELING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Veneered wood paneling.

1.02 RELATED REQUIREMENTS

A. 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 SUBMITTALS

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

B. Product Data: Provide data on fire-retardant treatment materials and application instructions.

C. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC sealants, finish treatments and adhesives.

D. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.

1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.

2. Provide plan of panel number sequencing.

E. Samples: Submit two samples of finished wood, 4 1/2 x 12 inch in size, illustrating wood grain and specified finish.

F. Samples: Submit two samples of wood trim, 6 inch long.

G. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

1.04 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.

B. 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.

1.05 MOCK-UP

A. Construct mock-up, 6 feet long by 6 feet wide, illustrating full panel sheet, edge trim, joint trim, applied finish .

B. Locate where directed.

C. Mock-up may remain as part of the Work if approved by architect.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect work from moisture damage.

B. Do not deliver wood materials to project site until building is fully enclosed and interior temperature and humidity are in accordance with recommendations of AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Comply with applicable codes for fire-retardant requirements.

2.02 PANELING

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless otherwise indicated.

B. Veneered Flat Paneling:

1. Species: Cherry.
2. Cut: Plain sliced.
3. Panels: Veneer of full width and balanced sequence matched.
4. Visible Edges and Reveals: Match faces.
5. Outside Corners: Mitered and splined.

2.03 WOOD-BASED MATERIALS - GENERAL

A. Provide sustainably harvested wood, certified or labeled as specified in Section 016000.

B. Wood fabricated from timber recovered from riverbeds or otherwise abandoned is permitted, unless indicated otherwise, and provided it is clean and free of contamination, identify source; provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc. (ALSC).

C. Fire-Rated Particleboard: Composed of wood chips, medium density, with waterproof resin binders; of grade to suit application; sanded faces; complying with ANSI A208.1.

2.04 ADHESIVES AND FASTENERS

A. Adhesives: Type suitable for intended purpose, complying with applicable air quality regulations.

B. Fasteners: Of size and type to suit application; Dark finish in concealed locations and Dark finish in exposed locations.

2.05 FABRICATION

A. Shop prepare and identify panels for grain matching during site erection.

B. Prepare panels for delivery to site, permitting passage through building openings.

C. Finish exposed edges of panels as specified by grade requirements.

D. When necessary to cut and fit on site, provide materials with ample allowance for cutting and scribing.

2.06 ACCESSORIES

A. Metal Trim:

1. Material: Extruded aluminum.
2. Manufacturers: Basis-of-Design as indicated on drawings.

B. Wood Filler: Tinted to match surface finish color.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated on shop drawings.

B. Verify adequacy of backing and support framing.

C. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION

A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.

B. Do not begin installation until wood materials have been fully acclimated to interior conditions.

C. Set and secure materials and components in place, plumb and level, using concealed fasteners wherever possible.

D. Where necessary to cut and fit on site, scribe work abutting other components. Do not use additional overlay trim to conceal gaps.

E. Set exposed fasteners, fill with wood filler, and finish to match panel finish.

F. Touch up damaged finish to match original, using materials provided by fabricator; replace components that cannot be refinished like new.

3.03 TOLERANCES

A. Maximum Variation from True Position: 1/16 inch.

B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

END OF SECTION 064200

SECTION 071300 - SHEET WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Self-adhering modified bituminous sheet waterproofing.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

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

1.03 ABBREVIATIONS

A. PVC - Polyvinyl Chloride.

B. SBS - Styrene-Butadiene-Styrene.

C. TPO - Thermoplastic Polyolefin.

D. UV - Ultraviolet.

1.04 SUBMITTALS

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

B. Product Data: Provide data for membrane.

C. Sustainable Design Submittals Include:

   a. Sustainable design requirements for recycled content.
   b. Sustainable design requirements for regional materials.
   c. Sustainable design requirements for Low VOC materials, sealants and adhesives.

D. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.

E. Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer's Installation Instructions: Indicate special procedures.

G. Manufacturer's qualification statement.

H. Installer's qualification statement.

I. Specimen warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

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

1.06 MOCK-UPS

A. Construct mock-up consisting of 100 sq ft of vertical waterproofed panel to represent finished work including internal and external corners.

B. Locate where directed.

C. Mock-up may remain as part of work.

1.07 FIELD CONDITIONS

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

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Contractor to correct defective work within a five-year period after Date of Substantial Completion; remove and replace materials concealing waterproofing at no extra cost to Owner.

C. Provide five year manufacturer warranty against failure of waterproofing to resist penetration of water, except where such failures are the result of structural failures of building.

1. Hairline cracking of concrete due to temperature change or concrete shrinkage is not considered a structural failure.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Sheet Waterproofing:

1. Carlisle Coatings & Waterproofing: www.carlisleccw.com/#sle.

2.02 PRODUCT TYPES

A. Self-Adhering Modified Bituminous Sheet Waterproofing:

1. Location: Building exterior foundation walls.
2. Vertical Surfaces: Self-adhered to concrete substrate.
3. Horizontal Surfaces: Self-adhered to concrete substrate.
4. Cover with protection fabric.

2.03 MATERIALS

A. Self-Adhering Modified Bituminous Sheet Waterproofing:

1. Basis-Of-Design Product:

a. Carlisle Coatings & Waterproofing Inc; MiraDRI 860/861.
b. Substitutions: See Section 016000 - Product Requirements.

2. Total Sheet Thickness: 60 mil, 0.060 inch, consisting of 56 mil, 0.056 inch rubberized asphalt laminated to 4 mil, 0.004 inch of polyethylene.
3. Sheet Width: 36 inches, minimum.
4. Tensile Strength:

a. Film: 5,000 psi, minimum, measured in accordance with ASTM D882.
b. Membrane: 325 psi, minimum, measured in accordance with ASTM D412.

5. Elongation at Break: 350 percent, minimum, measured in accordance with ASTM D412.
6. Water Vapor Permeance: 0.05 perm, maximum, measured in accordance with ASTM E96/E96M.
7. Low-Temperature Flexibility: Unaffected when tested in accordance with ASTM D1970/D1970M, 180-degree bend over 1 inch mandrel at minus 45 degrees F.
8. Peel Adhesive Bond: 10 lb per inch, minimum, when tested in accordance with ASTM D903.
9. Lap Adhesion Strength: 19 lb per inch, minimum, when tested in accordance with ASTM D1876.
10. Puncture Resistance: 60 lb, minimum, measured in accordance with ASTM E154/E154M.
11. Water Absorption: 0.1 percent increase in weight, maximum, measured in accordance with ASTM D570, 24 hour immersion.

12. Hydrostatic Head Pressure Resistance: Resists equivalent weight of 230 feet of water when tested in accordance with ASTM D5385/D5385M.
13. Ambient and Substrate Temperatures: Use applicable sheet membrane for ambient and substrate temperatures above or below 40 degrees F in compliance with manufacturer's requirements.
14. Protection Fabric: Nonwoven polypropylene fabric to protect sheet waterproofing for either horizontal (H) or vertical (V) applications.

    a. Thickness: 90 mil, 0.090 inch, minimum.
    b. Product:
        1) Carlisle Coatings & Waterproofing Inc; CCW 200V Protection Fabric.

15. Perimeter Drainage Composite: Nonwoven filter fabric bonded to individual dimples of molded polypropylene core to minimize fabric intrusion of flow channels, 1.0 inch thick.

    a. Width: 6 inches, minimum.
    b. Product:

        1) Carlisle Coatings & Waterproofing Inc; MiraDRAIN HC.

2.04 ACCESSORIES

A. Seaming Materials: As recommended by membrane manufacturer.

B. Membrane Sealant: As recommended by membrane manufacturer.

C. Adhesives: As recommended by membrane manufacturer.

D. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

E. Sealant for Cracks and Joints In Substrates: Resilient elastomeric joint sealant compatible with substrates and waterproofing materials, as recommended by membrane manufacturer.

F. Backer Rods: Closed-cell polyethylene foam rod, as recommended by membrane manufacturer.

G. Primer: Synthetic rubber solvent-based primer and surface cleaner.

    1. Product:

        a. Carlisle Coatings & Waterproofing Inc; Sure-Seal HP-250 Primer.

H. Lap Sealant: Heavy bodied trowel or gun-grade material with cured rubber consistency; used as sealant in mechanical terminations on vertical or horizontal surfaces.

    1. Color: Black.

2. Product:

    a. Carlisle Coatings & Waterproofing Inc; Sure-Seal Lap Sealant.

I. Inside/Outside Corners: Preformed inside or outside corners of 60 mil, 0.060 inch uncured Elastoform Flashing with preapplied adhesive for 88 mil, 0.088 inch total thickness

1. Size: 7 by 9 inches, nominal; may be installed as either inside or outside corner.
2. Color: Black.
3. Product:

    a. Carlisle Coatings & Waterproofing Inc; Sure-Seal Pressure-Sensitive Inside/Outside Corners.

J. Self-Curing Liquid Detailing Membrane: Two-component polyurethane waterproofing, self-curing for detailing penetrations on horizontal (H) and vertical (V) surfaces.

1. Product:
    a. Carlisle Coatings & Waterproofing Inc; CCW-703-H Self-Leveling Liquiseal.
    b. Carlisle Coatings & Waterproofing Inc; CCW-703-V Vertical Grade Liquiseal.

K. Termination Bar: Corrosion-resistant 6063-T6 extruded aluminum bar with prepunched holes at 6 inches on center and 1 inch from each end, used to secure and seal flashing terminations.

1. Size: 1 inch wide by 10 feet long, with serrated backside.
2. Product:

    a. Carlisle Coatings & Waterproofing Inc; Sure-Seal Termination Bar.

L. Bentonite Waterstop: Self-adhering, coiled waterstop strip of butyl rubber polymers and expandable bentonite clay waterproofing joint compound for use in nonmoving joints to create watertight concrete joints.

1. Size: 1 by 3/4 inch, nominal.
2. Product:

    a. Carlisle Coatings & Waterproofing Inc; MiraSTOP BW.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions are acceptable prior to starting this 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.

C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.

D. Fill nonmoving joints and cracks with a filler compatible with waterproofing materials.

E. Seal moving cracks with sealant and nonrigid filler, using procedures recommended by sealant and waterproofing manufacturers.

F. Prepare building expansion joints at locations as indicated on drawings.

G. Surfaces for Adhesive Bonding: Apply surface conditioner at a rate recommended by manufacturer; protect conditioner from rain or frost until dry.

3.03 INSTALLATION - MEMBRANE

A. Install membrane waterproofing in accordance with manufacturer's instructions.

B. Roll out membrane; 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, 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; seal joints and seams.

G. Coordinate with drain installation; see Section 221006.

H. Flexible Flashings: Seal items watertight that penetrate through waterproofing membrane.

I. Seal membrane and flashings to adjoining surfaces.

3.04 INSTALLATION - DRAINAGE COMPOSITE AND PROTECTION BOARD

A. Place drainage composite directly against membrane, butt joints, place to encourage drainage downward; scribe and cut boards around projections, penetrations, and interruptions.

B. Place protection board directly against drainage composite; butt joints, and scribe and cut boards around projections, penetrations, and interruptions.

C. Install perimeter drainage composite over drainage composite; butt joints.

3.05 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Owner will provide testing services, and Contractor to provide temporary construction and materials for testing.

C. Upon completion of horizontal membrane installation, dam installation area in preparation for flood testing.

1. Flood to minimum depth of 1 inch with clean water, and after 48 hours inspect for leaks.
2. If leaking is found, remove water, repair leaking areas with new waterproofing materials as directed by Architect; repeat flood test, and repair damage to building.
3. When area is proven watertight, drain water and remove dam.

3.06 PROTECTION

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

END OF SECTION 071300

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SECTION 072100 - THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Board insulation and integral vapor retarder at cavity wall construction, perimeter foundation wall, underside of floor slabs, and exterior wall behind exterior wall finish.

B. Batt insulation in exterior wall construction.

C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 072700 - Air Barriers: Separate air barrier materials.

C. Section 072119 - Foamed-In-Place Insulation: Installation requirements for foamed-in insulation.

1.03 DEFINITIONS

A. Mineral Fiber Material Composition: Insulation referred to as mineral fiber block, board, and blanket insulation is composed of fibers from mineral based substances such as rock, slag, or glass and processed from the molten state into fibrous form.

1. Based on type of insulation substance, the material will be referred to as a mineral fiber when having a rock or slag base, and glass fiber with a glass or silica sand base, also considered a mineral.
2. Insulation blankets are flexible units consisting of felted, bonded, or unbonded fibers formed into rolls or flat cut pieces referred to as batts; rolls are simply longer versions of batts.
3. For additional information about mineral fiber and the various classification types, refer to the following reference standards; ASTM C553, ASTM C612, ASTM C665, and ASTM C726.

1.04 SUBMITTALS

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

B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

C. Sustainable Design Submittals Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC sealants, materials and adhesives.

D. Shop Drawings: Submit drawings that indicate location of joint or termination detail conditions.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

G. ABAA Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.

1.05 QUALITY ASSURANCE

A. Air Barrier Association of America (ABAA) Evaluated Materials Program (EAP); www.airbarrier.org/#sle: Use evaluated materials from a single manufacturer regularly engaged in air barrier material manufacture. Use secondary materials approved in writing by primary material manufacturer.

1.06 FIELD CONDITIONS

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. Insulation Under Concrete Slabs: Extruded polystyrene (XPS) board.

B. Insulation Inside Concrete Stem Walls: Extruded polystyrene (XPS) board.

C. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.

2.02 FOAM BOARD INSULATION MATERIALS

A. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578 with either natural skin or cut cell surfaces.

1. Type and Compressive Resistance: Type IV, 25 psi (173 kPa), minimum.
2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
4. Type and Thermal Resistance, R-value: Type IV, 5.0 (0.88), minimum, per 1 inch thickness at 75 degrees F mean temperature.
5. Products:

    1. DuPont de Nemours, Inc: building.dupont.com/#sle.
    2. Kingspan Insulation LLC: www.kingspan.com/#sle.
    3. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
    4. Substitutions: See Section 016000 - Product Requirements.

2.03 MINERAL FIBER BOARD INSULATION MATERIALS

A. Mineral Wool Block and Board Thermal Insulation: Complying with ASTM C612.

1. Facing: None, unfaced.
2. Flame Spread Index: 25 or less, when tested with facing, if any, in accordance with ASTM E84.
3. Smoke Developed Index: 50 or less, when tested with facing, if any, in accordance with ASTM E84.
4. Board Thickness: 1 inch.
5. Board Edges: Square.
6. Thermal Conductivity (k-factor): Btu inch/hr sq ft degrees F of 0.26 per inch, minimum, at 75 degrees F when tested in accordance with ASTM C518.
7. Maximum Density: 8 pcf, nominal.
8. Products:

    1. CertainTeed Corporation: www.certainteed.com/#sle.
    2. Johns Manville: www.jm.com/#sle.
    3. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
    4. ROCKWOOL; COMFORTBOARD 110: www.rockwool.com/#sle.
    5. Substitutions: See Section 016000 - Product Requirements.

B. Mineral Wool Block, Board, or Blanket Thermal Insulation: Complying with ASTM C612 or ASTM C553.

1. Where indicated, provide black, non-woven fiberglass facing on one side; with flame spread index of 25 or less, when tested in accordance with ASTM E84.
2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
3. Board Size: 16 by 48 inches.
4. Board Thickness: 1 inch.
5. Maximum Density: 8 pcf, nominal.

6. Products:

    1. Johns Manville; CladStone Water & Fire Block Insulation: www.jm.com/sle.
    2. ROCKWOOL; CAVITYROCK BLACK: www.rockwool.com/sle.
    3. Thermafiber, Inc; RainBarrier: www.thermafiber.com/sle.
    4. Substitutions: See Section 016000 - Product Requirements.

2.04 MINERAL FIBER BLANKET INSULATION MATERIALS

A. Flexible Glass Fiber Blanket Thermal Insulation: Preformed insulation, complying with ASTM C665; friction fit.

1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
4. Formaldehyde Content: Zero.
5. Thermal Resistance: R-value of as indicated in drawings..
6. Facing: Unfaced.
7. Products:

    1. CertainTeed Corporation: www.certainteed.com/#sle.
    2. Johns Manville: www.jm.com/#sle.
    3. Owens Corning Corporation; EcoTouch PINK FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.

2.05 ACCESSORIES

A. Support for Cladding and Continuous Insulation: See respective cladding section.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.

B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION AT FOUNDATION PERIMETER

A. Install boards vertically on foundation perimeter.

B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION AT EXTERIOR WALLS

A. Install rigid insulation directly to steel studs or exterior grade sheathing at 16 inches on center with manufacturer recommended mechanical fasteners, and tape joints with manufacturer's minimum 4 inches wide sealant tape; comply with ASTM E2357.

B. Install boards vertically on walls.

1. Install in running bond pattern.
2. Butt edges and ends tightly to adjacent boards and protrusions.

C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.04 BOARD INSTALLATION AT CAVITY WALLS

A. Install boards to fit snugly between wall ties.

B. Install boards horizontally on walls.

C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.05 BOARD INSTALLATION UNDER CONCRETE SLABS

A. Place insulation under slabs on grade after base for slab has been compacted.

B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

C. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.

3.06 BATT INSTALLATION

A. Install insulation and vapor retarder in accordance with manufacturer's instructions.

B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.

C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

E. Coordinate work of this section with construction of air barrier seal, see Section 072700.

3.07 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Coordination of Air Barrier Association of America (ABAA) Tests and Inspections:

1. Provide testing and inspection required by ABAA Quality Assurance Program (QAP).
2. Notify ABAA in writing of schedule for air barrier work, and allow adequate time for testing and inspection.
3. Cooperate with ABAA testing agency.
4. Allow access to air barrier work areas and staging.
5. Do not cover air barrier work until tested, inspected, and accepted.

3.08 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 072100

SECTION 072119 - FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Foamed-in-place insulation.

1. In exterior framed walls.
2. In exterior wall crevices.
3. At junctions of dissimilar wall and roof materials.
4. In hollow structural steel.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

1.03 MINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week prior to commencing work of this section.

1.04 SUBMITTALS

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

B. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.

C. Sustainable Design Submittals Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

D. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.

E. Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.

F. Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer

certification on site during and after installation. Present on-site documentation upon request.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience, and approved by manufacturer.

C. Air Barrier Association of America (ABAA) Evaluated Materials Program (EAP); www.airbarrier.org/#sle: Use evaluated materials from a single manufacturer regularly engaged in air barrier material manufacture. Use secondary materials approved in writing by primary material manufacturer.

1.06 FIELD CONDITIONS

A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.

B. Do not apply foam when temperature is within 5 degrees F of dew point.

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. Huntsman Building Solutions; Heatlok HFO Pro: www.huntsmanbuildingsolutions.com/#sle.
3. Johns Manville; JM Corbond High Yield Open-Cell: www.jm.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 MATERIALS

A. Foamed-In-Place Insulation: Low-density, flexible, open cell or closed cell, water vapor permeable polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.

1. Thermal Resistance: R-value of 3.0, minimum, per 1 inch thickness at 75 degrees F mean temperature when tested in accordance with ASTM C518.
2. Air Permeance: 0.04 cfm per square foot, maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf.

3. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.

2.03 ACCESSORIES

A. Primer: As required by insulation manufacturer.

B. Protective Coating: Sprayed, treated with flame retardants as required to comply with applicable codes.

1. Coating Type: Recycled paper.
2. Thermal Resistance, R-value: 4.5, at 1 1-2 inch thickness when tested in accordance with ASTM C518.
3. Noise Reduction Coefficient (NRC): 0.95 for 1-1/4-inch thickness installed over foam.
4. Bond Strength: 100 psf, minimum.
5. Flame Spread/Smoke Developed Index: 5/5, Class A, when tested in accordance with ASTM E84.
6. Color: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify work within construction spaces or crevices is complete before insulation application.

B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation 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 insulation by spray method, to a uniform monolithic density without voids.

C. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts.

D. Trim excess away for applied trim or remove as required for continuous sealant bead.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Field inspections and tests will be performed by an independent testing agency.

3.05 PROTECTION

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

END OF SECTION 072119

SECTION 072700 - AIR BARRIERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air barriers.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 054000 - Cold-Formed Metal Framing : Air barrier under exterior cladding.

C. Section 074216 - Metal Wall Panel / Rainscreen Assembly: Air Barrier under exterior cladding.

D. Section 076200 - Sheet Metal Flashing and Trim: Metal flashings installed in conjunction with air barriers.

1.03 DEFINITIONS

A. Air Barrier: Airtight barrier made of material that is virtually air impermeable but water vapor permeable, both to amount as specified, with sealed seams and sealed joints to adjacent surfaces.

1.04 SUBMITTALS

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

B. Product Data: Provide data on material characteristics, performance criteria, limitations, and substrate preparation instructions and recommendations.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC liquid coatings, materials and adhesives.

D. Shop Drawings: Provide drawings of special joint conditions.

E. Manufacturer's Installation Instructions: Indicate preparation, installation methods, and storage and handling criteria.

F. Manufacturer's qualification statement.

G. Installer's qualification statement.

H. Testing agency qualification statement.

1.05 QUALITY ASSURANCE

A. Air Barrier Association of America (ABAA) Quality Assurance Program (QAP); www.airbarrier.org/#sle:

1. Installer Qualification: Use accredited contractor, certified installers, evaluated materials, and third-party field quality control audit.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

C. Manufacturer Qualification: Use evaluated materials from a single manufacturer regularly engaged in air barrier material manufacture, and use secondary materials approved in writing by primary material manufacturer.

D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.06 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional requirements.

B. Construct air barrier mock-up, 6 feet long by 4 feet wide, indicating wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly..

C. Locate where directed.

D. Mock-up may remain as part of work.

1.07 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by materials manufacturers before, during, and after installation.

PART 2 PRODUCTS

2.01 AIR BARRIER MATERIALS (AIR IMPERMEABLE AND WATER VAPOR PERMEABLE)

A. Air Barrier, Fluid Applied: Vapor semi-permeable, elastomeric waterproofing.

1. Air Barrier Membrane:

a. Material: Water-based polymer-modified bitumen.
b. Dry Film Thickness (DFT): 30 mil, 0.030 inch, minimum.
c. Air Permeance: 0.004 cfm/sq ft, maximum, when tested in accordance with ASTM E2178.
d. Water Vapor Permeance: 13 perms, minimum, when tested in accordance with ASTM E96/E96M using Procedure B - Water Method, at 73.4 degrees F.
e. Ultraviolet (UV) and Weathering Resistance: Approved by manufacturer for up to 90 days minimum of weather exposure.
f. Elongation: 300 percent, minimum, when tested in accordance with ASTM D412.
g. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A when tested in accordance with ASTM E84.
h. VOC Content: 6.7 oz/gal.
i. Sealants, Tapes and Accessories: As recommended by coating manufacturer.
j. Products:

1) Carlisle Coatings and Waterproofing, Inc; Fire Resist Barritech-VP: www.carlisleccw.com/#sle.
2) Tremco Commercial Sealants & Waterproofing; ExoAir 220: www.tremcosealants.com/#sle.
3) W. R. Meadows, Inc; Air-Shield LMP: www.wrmeadows.com/#sle.
4) Substitutions: See Section 016000 - Product Requirements.

2.02 ACCESSORIES

A. Sealants, Tapes, and Accessories for Sealing Air Barrier and Adjacent Substrates: As indicated or in compliance with air barrier manufacturer's installation instructions.

B. Sealant for Cracks and Joints In Substrates: Resilient elastomeric joint sealant compatible with substrate and air barrier materials.

1. Application: Apply at 30 to 40 mil, 0.030 to 0.040 inch, nominal thickness.
2. Color: Manufacturer's standard.
3. Elongation: Minimum 800 percent, measured in accordance with ASTM D412.

C. Primer: Liquid applied polymer.

1. Color: Manufacturer's standard..

2. Products:

    a. Basis of Design Product: Tremco, Inc., ExoAir Primer.
    b. Substitutions: See Section 016000 - Product Requirements.

D. Foil-Faced Self-Adhering Flashing: Membrane consisting of cross-laminated high-density polyethylene facer laminated to ultraviolet (UV) and weather-resistant exterior aluminum foil facer, using nonasphaltic, butyl-based adhesive to self-adhere to substrate.

1. Thickness: 22 mil, 0.022 inch, minimum.
2. Roll Size: 50 feet long by 4 inches wide.
3. Color: Silver aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and conditions are ready for work of this section.

B. Where existing conditions are responsibility of another installer, notify Architect of unsatisfactory conditions.

C. Do not proceed with this work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

B. Clean and prime substrate surfaces to receive adhesives and sealants in accordance with manufacturer's installation instructions.

3.03 INSTALLATION

A. Install materials in accordance with manufacturer's installation instructions.

B. Air Barriers: Install continuous airtight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.

C. Apply sealants and adhesives within recommended temperature range in accordance with manufacturer's installation instructions.

D. Fluid-Applied Coatings or Membranes:

1. Prepare substrate in accordance with manufacturer's installation instructions; treat joints in substrate and between dissimilar materials as indicated.

2. Use flashing to seal to adjacent construction and to bridge joints in coating substrate.

E. Openings and Penetrations in Exterior Air Barriers:

1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches onto air barrier and at least 6 inches up jambs; mechanically fasten stretched edges.
2. At openings with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches wide; do not seal sill flange.
3. At openings with nonflanged frames, seal air barrier to each side of framing at opening using flashing at least 9 inches wide, and covering entire depth of framing.
4. At head of openings, install flashing under air barrier extending at least 2 inches beyond face of jambs; seal air barrier to flashing.
5. At interior face of openings, seal gap between window/door frame and rough framing, using joint sealant over backer rod.
6. Service and Other Penetrations: Form flashing around penetrating item and seal to air barrier surface.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Coordination of ABAA Tests and Inspections:

1. Provide testing and inspection required by ABAA QAP.
2. Notify ABAA in writing of schedule for air barrier work, and allow adequate time for testing and inspection.
3. Cooperate with ABAA testing agency.
4. Allow access to air barrier work areas and staging.
5. Do not cover air barrier work until tested, inspected, and accepted.

C. Do not cover installed air barriers until required inspections have been completed.

3.05 PROTECTION

A. Do not leave materials exposed to weather longer than recommended by manufacturer.

END OF SECTION 072700

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SECTION 074213 - METAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured metal panels for exterior wall panels and subgirt framing assembly, with related flashings and accessory components.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 054000 - Cold-Formed Metal Framing: Wall panel substrate.

C. Section 072100 - Thermal Insulation.

D. Section 072500 - Weather Barriers: Weather barrier under wall panels.

E. Section 072700 - Air Barriers: Air barrier under wall panels.

F. Section 092116 - Gypsum Board Assemblies: Wall panel substrate.

1.03 SUBMITTALS

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

B. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:

1. Physical characteristics of components shown on shop drawings.
2. Storage and handling requirements and recommendations.
3. Installation instructions and recommendations.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, materials and adhesives.

D. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, flashings, special fabrication provisions for termination and penetrations, and methods of anchorage.

E. Samples: Submit two samples of wall panel, 12 inches by 12 inches in size illustrating finish color, sheen, and texture.

F. Manufacturer's qualification statement.

G. Installer's qualification statement.

H. Warranty Documentation for Installation of Building Rainscreen Assembly: Submit installer warranty and ensure that forms have been completed in Owner's name and registered with installer.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in installing products specified in this section with minimum three years of documented experience.

C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.05 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional requirements.

B. Construct mock-up, 9 feet long by 5 feet wide; include panel system, glazing, attachments to building frame, associated vapor retarder and air seal materials, weep drainage system, sealants and seals, and related insulation in mock-up.

C. Locate as directed by Architect.

1.06 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.

C. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.

D. Prevent contact with materials that may cause discoloration or staining of products.

1.07 FIELD CONDITIONS

A. Do not install wall panels when air temperature or relative humidity are outside manufacturer's limits.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Finish Warranty: Provide 10-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

C. Special Warranty: Provide 3-year warranty covering water tightness and integrity of seals of metal wall panels. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Wall Panels - Concealed Fasteners:

1. Berridge Manufacturing Company; BR-12 Panel: www.berridge.com/#sle.
2. Petersen Aluminum Corporation; Box Rib 1: www.pac-clad.com/#sle.
3. Innovative Metals Company, Inc. (IMETCO); Latitude Box Rib B: www.imetco.com.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 METAL WALL PANEL SYSTEM

A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.

1. Provide exterior wall panels and subgirt framing assembly.
2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
3. Design Pressure: In accordance with Structural General Notes.
4. Maximum Allowable Deflection of Panel: L/180 for length(L) of span.
5. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
6. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
7. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.

8. Corners: Factory-fabricated in one continuous piece with minimum 2-inch returns.
9. Provide continuity of air barrier seal at building enclosure elements in accordance with requirements; see Section 072700.

B. Exterior Wall Panels: MP1

1. Profile: IMECTO Latitude Panel Box Rib B – Perforated
2. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.
3. Material: Precoated aluminum sheet, 16 gauge, 0.0508 inch minimum thickness.
4. Panel Width: 16 inches.
5. Perforation: 1/8" Diameter Holes @ 1/4" Centers, 23% open area.

C. Exterior Wall Panels: MP2

1. Profile: IMECTO Element Perforated
2. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.
3. Material: Precoated aluminum sheet, 12 gauge, 0.080 inch minimum thickness.
4. Panel Width: 16 inches.
5. Perforation: 1/8" Diameter Holes @ 1/4" Centers, 23% open area.
6. Finish: Single side Brite Copper.

D. Exterior Wall Panels: MP3

1. Profile: Horizontal Insulated Panel; Flat
2. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.
3. Material: Precoated aluminum sheet, 16 gauge, 0.0508 inch minimum thickness.
4. Panel Width: 16 inches.
5. Finish: Painted to match exterior Hollow Metal Doors color.

E. Subgirt Framing Assembly:

F. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.

G. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

H. Anchors: Galvanized steel.

2.03 MATERIALS

A. Precoated Aluminum Sheet: ASTM B209/B209M, 3105 alloy, O temper, with smooth surface texture; continuous-coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

2.04 FINISHES

A. High Performance Organic Coating System: Multi-coat, high-durable polyester system.

1. Systems: Exposed Surfaces: 2-Coat Fluoropolymer finish in accordance with AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Manufacturers' approved applicator to prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. 2-sided surface coating system shall provide nominal 1.0 mil dry film thickness, consisting of primer and color coat.
3. Color shall be IMETCO's Brite Copper and as indicated

2.05 ACCESSORIES

A. Support for Cladding and Continuous Insulation: Thermal clips.

1. Thermally-broken clips that provide attachment support for girts, angles, channels, and other cladding support framing.
2. Fasteners: As recommended by clip manufacturer.

B. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot dip galvanized. Fastener cap same color as exterior panel.

C. Sealants:

1. Sealant Tape: Non-curing, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1-inch- (13-mm-) wide and 1/16-inch- (3-mm-) thick.
2. Exposed Sealant: ASTM C920; elastomeric tripolymer, polyurethane, or other advanced polymer sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
3. Concealed Sealant: ASTM C1311: Butyl-Based, Solvent-Release, One-Part Sealant.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building framing members are ready to receive panels.

B. Verify air barrier, see Section 072700, has been installed over wall panel substrate; see Section 054000.

3.02 PREPARATION

A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane, and spaced at intervals indicated.

B. Protect surrounding areas and adjacent surfaces from damage during execution of this work.

3.03 INSTALLATION

A. Install panels on walls and soffits in accordance with manufacturer's instructions.

3.04 TOLERANCES

A. Offset From True Alignment Between Adjacent Members Abutting or In Line: 1/16 inch, maximum.

B. Variation from Plane or Location As Indicated on Drawings: 1/4 inch, maximum.

3.05 CLEANING

A. Remove site cuttings from finish surfaces.

B. Remove protective material from wall panel surfaces.

C. Upon completion of installation, thoroughly clean prefinished aluminum surfaces in accordance with AAMA 609 & 610.

3.06 PROTECTION

A. Protect metal wall panels until completion of project.

B. Touch-up, repair, or replace damaged wall panels or accessories before Date of Substantial Completion.

END OF SECTION 074213

DFCM REGIONAL CENTER - FARMINGTON
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FARMINGTON, UT 84025

SECTION 075400 - THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mechanically attached system with thermoplastic roofing membrane.

B. Adhered system with thermoplastic roofing membrane.

C. Insulation, flat and tapered.

D. Vapor retarder.

E. Cover boards.

F. Flashings.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 053100 - Steel Decking: Placement of acoustical insulation for deck flutes.

C. Section 077100 - Roof Specialties: Prefabricated roofing expansion joint flashing.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting roof deck construction.

1. Review preparation and installation procedures and coordinating and scheduling required with related work.
2. Meet with Owner, Architect, Construction Manager (CMGC), DFCM Roofing Program Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
3. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
4. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
5. Review deck substrate requirements for conditions and finishes, including flatness and fastening.

6. Review structural loading limitations of roof deck during and after roofing.
7. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
8. Review governing regulations and requirements for insurance and certificates if applicable.
9. Review temporary protection requirements for roofing system during and after installation.
10. Review roof observation and repair procedures after roofing installation.
11. Review DFCM Roofing Standards and Warranty requirements.

B. Preinstallation Meeting: Convene one week before starting the work of this section.

1. Meet with Owner, Architect, Construction Manager (CMGC), Owner's Roofing Program Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.
10. Review DFCM Roofing Standards and Warranty requirements.

1.04 SUBMITTALS

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

B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC materials, sealants and adhesives.

D. Shop Drawings: Submit drawings that indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.

E. Samples for Verification: Submit two samples 12 by 12 inches in size illustrating insulation and colored coating.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.

H. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.

I. Manufacturer's qualification statement.

J. Installer's qualification statement.

K. Testing firm's qualification statement.

L. Sustainable Design Documentation: Test report showing solar reflectance index of membrane.

M. Specimen Warranty: For approval.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of this section with at least three years of documented experience.

C. Testing Firm Qualifications: Company specializing in performing work of the type specified and approved by manufacturer.

D. Single-Source Responsibility for Vegetated Roof Assemblies Over Waterproofing: Provide and install products from a single source.

1.06 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact, unless otherwise indicated.

C. Store materials in weather protected environment, clear of ground and moisture.

D. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.

E. Protect foam insulation from direct exposure to sunlight.

1.07 FIELD CONDITIONS

A. Do not apply roofing membrane during unsuitable weather.

B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above 90 degrees F.

C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thermoplastic Polyvinyl Chloride (PVC) Membrane Roofing Materials:

1. Carlisle SynTec Systems; Sure-Flex PVC: www.carlisle-syntec.com/#sle.
2. Elevate; Elevate PVC Membrane: www.holcimelevate.com/#sle.
3. Sika Corporation Roofing; Sarnafil PVC: usa.sika.com/sarnafil/#sle.

B. Insulation:

1. Carlisle SynTec Systems; SecurShield Insulation: www.carlisle-syntec.com/#sle.
2. Sika Corporation; Sarnatherm ISO.
3. Elevate; ISOGARD GL

C. Cover Boards:

1. Gypsum-Based Cover Board: Non-combustible, water-resistant gypsum core with embedded glass mat facers, complying with ASTM C 1177/C 1177M
2. USG: Securock Brand Gypsum-Fiber Roof Board.
3. Georgia-Pacific Gypsum: DensDeck Roof Board
4. Substitutions: See Section 016000 - Product Requirements.

2.02 MEMBRANE ROOFING AND ASSOCIATED MATERIALS

A. Membrane Roofing Materials:

1. Sheet Width:
2. Solar Reflectance: 0.75, minimum, initial, and 0.65, minimum, 3-year, certified by Cool Roof Rating Council.
3. Color: White.

B. Seaming Materials: As recommended by membrane manufacturer.

C. Membrane Fasteners: As recommended and approved by membrane manufacturer.

D. Vapor Retarder: Material approved by roof manufacturer complying with requirements of fire rating classification; compatible with roofing and insulation materials.

1. Fire-retardant adhesive.

2. Vapor Permeability: 0.015 perm inch, measured in accordance with ASTM E96/E96M.

E. Flexible Flashing Material: Same material as membrane.

F. Through-Wall Flashing: Cold-applied, self-adhering, styrene-butadiene-styrene (SBS) modified rubberized asphalt sheet membrane bonded with high density cross-woven polyethylene film.

1. Thickness: 47 mil, 0.047 inch, minimum.

2. Width: 12 inches, minimum.

2.03 COVER BOARDS

A. Cover Boards: Glass-mat faced gypsum panels complying with ASTM C1177/C1177M.

1. Thickness: 1/4 inch, fire-resistant.

2. Products:
   a. Georgia-Pacific; DensDeck Prime with EONIC Technology: www.densdeck.com/#sle.
   b. Gold Bond Building Products, LLC provided by National Gypsum Company; DEXcell Glass Mat Roof Board: www.goldbondbuilding.com/#sle.
   c. USG Corporation; Securock Ultralight Coated Glass-Mat Roof Board: www.usg.com/#sle..

2.04 INSULATION

A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, complying with ASTM C1289.

1. Classifications:

    a. Type II: Faced with either cellulosic facers or glass fiber mat facers on both major surfaces of the core foam.

        1) Class 1 - Faced with glass fiber reinforced cellulosic facers on both major surfaces of the core foam.
        2) Compressive Strength: Classes 1-2-3, Grade 1, 16 psi (110 kPa), minimum.
        3) Thermal Resistance, R-value: At 1-1/2 inches thick; Class 1, Grades 1-2-3, 8.4 (1.48), minimum, at 75 degrees F.

2. Board Size: 48 by 96 inches.
3. Board Thickness: 2.0 inches.
4. Tapered Board: Slope as indicated; minimum thickness 1/8 inch; fabricate of fewest layers possible.
5. Board Edges: Square.

B. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578, with natural skin surface and drainage channels on one face.

1. Board Size: 48 by 96 inches.
2. Board Thickness: 1-1/2 inches.
3. Tapered Board: Slope as indicated; minimum thickness 1/2 inch; fabricate of fewest layers possible.

2.05 ACCESSORIES

A. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.

B. Membrane Adhesive: As recommended by membrane manufacturer.

C. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.

1. Composition: Roofing membrane manufacturer's standard.
2. Surface Color: White or Yellow.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

B. Verify deck is supported and secure.

C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.

D. Verify deck surfaces are dry and free of snow or ice.

E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.02 INSTALLATION, GENERAL

A. Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.

B. Do not apply roofing membrane during cold or wet weather conditions.

C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.

D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.03 INSTALLATION - VAPOR RETARDER AND INSULATION, UNDER MEMBRANE

A. Install vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.

1. Extend vapor retarder under cant strips and blocking to deck edge.
2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.

B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.

C. Attachment of Insulation:

1. Mechanically fasten subsequent layer of insulation to deck in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.

D. Cover Boards: Mechanically fasten cover boards in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.

E. Lay subsequent layers of insulation with joints staggered minimum 6 inches from joints of preceding layer.

F. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.

G. Do not install more insulation than can be covered with membrane in same day.

3.04 INSTALLATION - MEMBRANE

A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.

B. Shingle joints on sloped substrate in direction of drainage.

C. Fully Adhered Application: Apply adhesive to substrate at rate of 1.5 - 2 gallons per square foot. Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.

D. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

E. At intersections with vertical surfaces:

1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
2. Fully adhere flexible flashing over membrane and up to nailing strips.

F. Around roof penetrations, seal flanges and flashings with flexible flashing.

G. Coordinate installation of roof drains and sumps and related flashings.

3.05 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Owner will provide testing services, and Contractor to provide temporary construction and materials for testing in accordance with requirements.

C. Provide daily on-site attendance of roofing and insulation manufacturer's representative during installation of this work.

3.06 CLEANING

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

B. Remove bituminous markings from finished surfaces.

C. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.

D. Repair or replace defaced or damaged finishes caused by work of this section.

3.07 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION 075400

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SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fabricated sheet metal items, including flashings, counterflashings, exterior penetrations, and other items indicated in Schedule.

B. Sealants for joints within sheet metal fabrications.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

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.

B. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

1.05 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 SHEET MATERIALS

A. Anodized Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 20 gauge, 0.032 inch thick; anodized finish of Bronze color.

1. Color Anodized Finish: AAMA 611, AA-M12C22A42/44, Class I, integrally or electrolytically colored anodic coating not less than 0.7 mil, 0.0007 inch thick.

a. Color: As selected by Architect from manufacturer's standard colors.

B. Metallic-Coated Steel Sheet: Provide aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40: prepainted by coil-coating process to comply with ASTM A755/A755M.

1. Surface: Smooth, flat and with manufacturer's standard clear acrylic coating on both sides.
2. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2.02 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; miter and seam corners.

D. Form material with standing 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 long legs; seam for rigidity, seal with sealant.

F. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.03 FLASHING

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

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.

3.03 INSTALLATION

A. Comply with drawing details.

B. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..

C. Apply plastic cement compound between metal flashings and felt flashings.

D. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.

E. Seal metal joints watertight.

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.

3.05 SCHEDULE

A. Through-Wall Flashing in Masonry:

B. Coping, Cap, Parapet, Sill and Ledge Flashings:

C. Counterflashings at Roofing Terminations (over roofing base flashings):

D. Counterflashings at Curb-Mounted Roof Items, including skylights and roof hatches:

E. Roofing Penetration Flashings, for Pipes, Structural Steel, and Equipment Supports:

END OF SECTION 076200

SECTION 077100 - ROOF SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured roof specialties, including copings, fascias, and gravel stops.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 077200 - Roof Accessories: Manufactured curbs, roof hatches, and snow guards.

1.03 SUBMITTALS

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

B. Product Data: Provide data on shape of components, materials and finishes, anchor types and locations.

C. Sustainable Design Submittals Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

D. Shop Drawings: Indicate configuration and dimension of components, adjacent construction, required clearances and tolerances, and other affected work.

E. Samples: Submit two appropriately sized samples of coping.

F. Manufacturer's Installation Instructions: Indicate special procedures, fasteners, supporting members, and perimeter conditions requiring special attention.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Roof Edge Flashings and Copings:

1. ATAS International, Inc; Gravel Stop Fascia: www.atas.com/#sle.
2. Hickman Edge Systems; Gravel Stop: www.hickmanedgesystems.com/#sle.
3. Metal Roofing Systems, Inc; Secure Lock Gravel Stop : www.metalroofingsystems.biz/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 COMPONENTS

A. Roof Edge Flashings: Factory fabricated to sizes required; corners mitered; concealed fasteners.

1. Configuration: Fascia, cant, and edge securement for roof membrane.
2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test methods RE-1 and RE-2 to positive and negative design wind pressure as defined by applicable local building code.
3. Material: Formed steel sheet, galvanized, 24 gauge, 0.024 inch thick, minimum.
4. Color: As indicated on drawings.

B. Copings: Factory fabricated to sizes required; corners mitered; concealed fasteners.

1. Configuration: Concealed continuous hold down cleat at both legs; internal splice piece at joints of same material, thickness, and finish as cap; concealed stainless steel fasteners.
2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-3 to positive and negative design wind pressure as defined by applicable local building code.
3. Wall Width: As indicated on drawings.
4. Outside Face Height: As indicated on drawings.
5. Inside Face Height: As indicated on drawings.
6. Material: Formed aluminum sheet, 0.040 inch thick, minimum.
7. Finish: Anodized bronze.
8. Products:

    1. ATAS International, Inc; Continuous Cleat Coping: www.atas.com/#sle.
    2. Hickman Edge Systems; PermaSnap Premier Coping : www.hickmanedgesystems.com/#sle.
    3. Metal-Era Inc; One Edge Coping: www.metalera.com/#sle.

2.03 FINISHES

A. Color Anodized Finish: AAMA 611 AA-M12C22A42/44 Class I integrally or electrolytically colored anodic coating not less than 0.7 mil, 0.0007 inch thick.

B. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; color as indicated.

2.04 ACCESSORIES

A. Sealant for Joints in Linear Components: As recommended by component manufacturer.

B. Adhesive for Anchoring to Roof Membrane: Compatible with roof membrane and approved by roof membrane manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.

3.02 INSTALLATION

A. Install components in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.

B. Seal joints within components when required by component manufacturer.

C. Anchor components securely.

D. Coordinate installation of components of this section with installation of roofing membrane and base flashings.

E. Coordinate installation of sealants and roofing cement with work of this section to ensure water tightness.

END OF SECTION 077100

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SECTION 077200 - ROOF ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof curbs.

B. Rooftop mounted guardrails.

C. Roof hatches.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 077100 - Roof Specialties: Other manufactured roof specialty items.

1.03 SUBMITTALS

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

B. Product Data: Manufacturer's data sheets on each product to be used.

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Maintenance requirements.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

D. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.

E. Warranty Documentation:

1. Submit manufacturer warranty.
2. Ensure that forms have been completed in Owner's name and registered with manufacturer.

3. Submit documentation that roof accessories are acceptable to roofing manufacturer, and do not limit the roofing warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store products under cover and elevated above grade.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 ROOFTOP MOUNTED GUARDRAILS

A. Non-Penetrating Rooftop Mounted Guardrails: At roof hatch:

1. Provide top and mid railings that comply with 29 CFR 1910.29.
2. Structural Load: 200 lb, minimum, in any direction with components in compliance with 29 CFR 1926.502.
3. Height: 42 inches, minimum.
4. Railings: 1-5/8 inches minimum outside diameter, hot-rolled, welded tubing, free of sharp edges and snag points.
5. Receiver Posts: Provide with positive locking system for placement in receiver holes of mounting bases that allow rails to be mounted in any direction; provide drain holes in receiver posts.
6. Steel Surface Finish: Hot-dip zinc galvanized, with color of safety yellow.

2.02 ROOF HATCHES AND VENTS

A. Roof Hatch Manufacturers:

1. Activar Construction Products Group, Inc. - JL Industries; Diamond Series Roof Hatches, Model RHDG: www.activarcpg.com/#sle.
2. Acudor Products Inc; Galvanized Steel Roof Hatch: www.acudor.com/#sle.
3. Best Access Doors; Series BA-GRH - Ladder Access Roof Hatch, Galvanized: www.bestaccessdoors.com/#sle.
4. Bilco Company; Type TB (various types and special size): www.bilco.com/#sle.
5. Precision Ladders, LLC; Model PH-A: www.precisionladders.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

2.03 NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES

A. Non-Penetrating Rooftop Support/Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.

1. Design Loadings and Configurations: As required by applicable codes.
2. Support Spacing and Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
3. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
4. Hardware, Bolts, Nuts, and Washers: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

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.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.04 CLEANING

A. Clean installed work to like-new condition.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 077200

SECTION 078400 - FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 017000 - Execution and Closeout Requirements: Cutting and patching.

C. Section 018113 .14 – Sustainable Design Requirements – HPBS.

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

1.03 SUBMITTALS

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

B. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

C. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.

D. Product Data: Provide data on product characteristics, performance ratings, and limitations.

E. Sustainable Design Submittal: Submit VOC content documentation for nonpreformed materials.

F. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

G. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

H. Certificate from authority having jurisdiction indicating approval of materials used.

I. Manufacturer's qualification statement.

J. Installer's qualification statement.

1.04 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.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section and:

1. Trained by manufacturer.
2. Verification of minimum three years documented experience installing work of this type.
3. Verification of at least five satisfactorily completed projects of comparable size and type.

1.05 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional requirements.

B. Install one firestopping assembly representative of each fire rating design required on project.

1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.

C. If accepted, mock-up will represent minimum standard for this work.

D. If accepted, mock-up may remain as part of this work. Remove and replace mock-ups not accepted.

1.06 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.

B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.

B. Mold and Mildew Resistance: Provide firestopping materials with mold and mildew resistance rating of zero(0) in accordance with ASTM G21.

C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

D. Fire Ratings: Refer to drawings for required systems and ratings.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.

B. 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.

1. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

2.03 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.

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.

B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.

C. Do not cover installed firestopping until inspected by authorities having jurisdiction.

3.04 FIELD QUALITY CONTROL

A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174 and ASTM E2393.

B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 078400

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SECTION 079200 - JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nonsag gunnable joint sealants.

B. Self-leveling pourable joint sealants.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions: Additional requirements for sealants and primers.

B. Section 018113 .14 – Sustainable Design Requirements – HPBS.

1.03 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. Backing material recommended by sealant manufacturer.
4. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
5. Substrates the product should not be used on.
6. Substrates for which use of primer is required.
7. Sample product warranty.

C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.

D. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC sealants and adhesives.

E. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.

F. Sustainable Design Documentation: For sealants and primers, submit VOC content and emissions documentation; see Section 016116.

G. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.

H. Installation Plan: Submit at least four weeks prior to start of installation.

I. Preinstallation Field Adhesion Test Plan: Submit at least two weeks prior to start of installation.

J. Field Quality Control Plan: Submit at least two weeks prior to start of installation.

K. Preinstallation Field Adhesion Test Reports: Submit filled out Preinstallation Field Adhesion Test Reports log within 10 days after completion of tests; include bagged test samples and photographic records.

L. Installation Log: Submit filled-out log for each length or instance of sealant installed.

M. Field Quality Control Log: Submit filled-out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

N. Manufacturer's qualification statement.

O. Installer's qualification statement.

P. Executed warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.

C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

D. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.

1. Adhesion Testing: In accordance with ASTM C794.
2. Compatibility Testing: In accordance with ASTM C1087.
3. Allow sufficient time for testing to avoid delaying the work.
4. Deliver sufficient samples to manufacturer for testing.

5. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.

E. Installation Plan: Include schedule of sealed joints, including the following:

1. Method to be used to protect adjacent surfaces from sealant droppings and smears, with acknowledgment that some surfaces cannot be cleaned to like-new condition and therefore prevention is imperative.

2. Installation Log Form: Include the following data fields, with known information filled out.

a. Date of installation.
b. Name of installer.
c. Actual joint width; provide space to indicate maximum and minimum width.
d. Actual joint depth to face of backing material at centerline of joint.
e. Air temperature.

F. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.

1. Identification of testing agency.
2. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.

a. Test date.
b. Copy of test method documents.
c. Age of sealant upon date of testing.
d. Test results, modeled after the sample form in the test method document.
e. Indicate use of photographic record of test.

G. Field Quality Control Plan:

1. Visual inspection of entire length of sealant joints.
2. Nondestructive field adhesion testing of sealant joints, except interior acrylic latex sealants.

a. For each different sealant and substrate combination, allow for one test every 12 inches in the first 10 linear feet of joint and one test every 24 inches thereafter.
b. If any failures occur in the first 10 linear feet, continue testing at 12 inches intervals at no extra cost to Owner.

3. Field testing agency's qualifications.
4. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field

testing; allow for possibility that more tests than minimum specified may be necessary.

H. Field Adhesion Test Procedures:

1. Allow sealants to fully cure as recommended by manufacturer before testing.
2. Have a copy of the test method document available during tests.
3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
4. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies.
5. Deliver the samples removed during destructive tests in separate sealed plastic bags, identified with project, location, test date, and test results, to Owner.
6. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.

I. Nondestructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Nondestructive Spot Method.

J. Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Destructive Tail Procedure.

1. Sample: At least 18 inches long.
2. Minimum Elongation Without Adhesive Failure: Consider the tail at rest, not under any elongation stress; multiply the stated movement capability of the sealant in percent by two; then multiply 1 inch by that percentage; if adhesion failure occurs before the 1-inch mark is that distance from the substrate, the test has failed.
3. If either adhesive or cohesive failure occurs before minimum elongation, take necessary measures to correct conditions and retest; record each modification to products or installation procedures.

K. Field Adhesion Tests of Joints: Test for adhesion using most appropriate method in accordance with ASTM C1521, or another applicable method as recommended by manufacturer.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nonsag Sealants:

1. Pecora Corporation: www.pecora.com/#sle.
2. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.

B. Self-Leveling Sealants:

2.02 JOINT SEALANT APPLICATIONS

A. Scope:

1. Exterior Joints:

a. Do not seal exterior joints unless indicated on drawings as sealed.
b. Seal the following joints:

1) Wall expansion and control joints.
2) Joints between doors, windows, and other frames or adjacent construction.
3) Joints between different exposed materials.

2. Interior Joints:

a. Do not seal gaps and openings in gypsum board and suspended ceilings
b. Seal the following joints:

1) Joints between door frames and window frames and adjacent construction.

3. Do Not Seal:

a. Intentional weep holes in masonry.
b. Joints indicated to be covered with expansion joint cover assemblies.
c. Joints where sealant installation is specified in other sections.

B. Interior Wet Areas: Bathrooms, restrooms, and kitchens; fixtures in wet areas include plumbing fixtures, countertops, cabinets, and other similar items.

2.03 JOINT SEALANTS - GENERAL

A. Sealants and Primers: Provide products with acceptable levels of volatile organic compound (VOC) content; see Section 016116.

B. Colors: As indicated on drawings.

2.04 NONSAG JOINT SEALANTS

A. Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.

1. Movement Capability: Plus and minus 25 percent, minimum.
2. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
3. Color: Match adjacent finished surfaces.
4. Service Temperature Range: Minus 65 to 180 degrees F.
5. Products:

a. Dow; DOWSIL 999-A Building and Glazing Sealant: www.dow.com/#sle.

B. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.

1. Color: Clear.
2. Products:

a. Adfast USA Inc; ADSEAL KB 4800 Series: www.adfastcorp.com/#sle.
b. Everkem Diversified Products, Inc; TruSil 100: www.everkemproducts.com/#sle.
c. Pecora Corporation; Pecora 898 NST (Non-Staining Technology): www.pecora.com/#sle.
d. Sika Corporation; Sikasil GP: www.usa.sika.com/#sle.

2.05 SELF-LEVELING JOINT SEALANTS

A. Self-Leveling Polyurethane Sealant for Horizontal Expansion Joints: ASTM C920, Grade P, Uses T, M, and O; multicomponent; explicitly approved by manufacturer for horizontal expansion joints.

1. Movement Capability: Plus and minus 25 percent, minimum.
2. Hardness Range: 30 to 35, Shore A, when tested in accordance with ASTM C661.
3. Color: To be selected by Architect from manufacturer's standard range.
4. Tensile Strength: 200 to 250 psi in accordance with ASTM D412.
5. Products:

a. Pecora Corporation; Urexpan NR-200: www.pecora.com/#sle.
b. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

C. Preinstallation Adhesion Testing: Install a sample for each test location indicated in the test plan.

1. Test each sample as specified in PART 1 under QUALITY ASSURANCE article.
2. Notify Architect of date and time that tests will be performed, at least seven days in advance.
3. Record each test on Preinstallation Adhesion Test Log as indicated.
4. If any sample fails, review products and installation procedures, consult manufacturer, or take other measures that are necessary to ensure adhesion; retest in a different location; if unable to obtain satisfactory adhesion, report to Architect.
5. After completion of tests, remove remaining sample material and prepare joints for new sealant installation.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Provide joint sealant installations complying with ASTM C1193.

C. Install bond breaker backing tape where backer rod cannot be used.

D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.

E. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.

F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.

C. Non-Destructive Adhesion Testing: If there are any failures in first 100 linear feet, notify Architect immediately.

D. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

3.05 POST-OCCUPANCY

A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width, i.e., at low temperature in thermal cycle. Report failures immediately and repair them.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

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

B. Hollow metal frames for wood doors.

C. Fire-rated hollow metal doors and frames.

D. Thermally insulated hollow metal doors with frames.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 087100 - Door Hardware.

C. Section 088000 - Glazing: Glass for doors and borrowed lites.

D. Section 099123 - Interior Painting: Field painting.

E. Section 099600 - High-Performance Coatings: 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. SDI: Steel Door Institute.

G. UL: Underwriters Laboratories.

1.04 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.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

D. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

E. Samples: Submit two samples of metal, 2 by 2 inches in size, showing factory finishes, colors, and surface texture.

F. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

G. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

H. Manufacturer's Qualification Statement.

I. Installer's Qualification Statement.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.

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

C. Maintain at project site copies of reference standards relating to installation of products specified.

1.06 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. Mesker, dormakaba Group; FDJ Series Drywall Frames: www.meskeropeningsgroup.com/#sle.
3. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
4. Steelcraft, an Allegion brand: www.allegion.com/#sle.
5. 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; galvannealed 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.
3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
4. Door Edge Profile: Manufacturers standard for application indicated.
5. Typical Door Face Sheets: Flush.
6. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

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. Door Finish: Factory primed and field finished.

B. Exterior Doors: Thermally insulated.

1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).

a. Level 3 - Extra Heavy-duty.
b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
c. Model 1 - Full Flush.

d. Door Face Metal Thickness: 16 gauge, 0.053 inch, minimum.
e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.

2. Door Core Material: Polyisocyanurate, 2 lbs/cu ft minimum density.

a. Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.

3. Door Thermal Resistance: R-Value of 9.9, minimum, for installed thickness of polyisocyanurate.
4. Door Thickness: 1-3/4 inches, nominal.
5. Weatherstripping: Refer to Section 087100.

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. Frame Finish: Factory primed and field finished.

C. Exterior Door Frames: Full profile/continuously welded type.

1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
2. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
3. Weatherstripping: Separate, see Section 087100.

D. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.

1. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.

E. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.

2.05 FINISHES

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

2.06 ACCESSORIES

A. Glazing: As specified in Section 088000, factory installed.

B. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.

C. Grout for Frames: Mortar grout complying with ASTM C476 with maximum slump of 4 inches as measured in accordance with ASTM C143/C143M for hand troweling in place; plaster grout and thinner pumpable grout are prohibited.

D. 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.

E. 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 PREPARATION

A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 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. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

D. Install door hardware as specified in Section 087100.

E. Comply with glazing installation requirements of Section 088000.

F. Coordinate installation of electrical connections to electrical hardware items.

G. Touch up damaged factory finishes.

3.04 TOLERANCES

A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.05 ADJUSTING

A. Adjust for smooth and balanced door movement.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flush wood doors; flush and flush glazed configuration; non-rated.

B. Attack-resistant door opening assemblies.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 081113 - Hollow Metal Doors and Frames.

C. Section 087100 - Door Hardware.

D. Section 088000 - Glazing.

E. Section 092116 - Gypsum Board Assemblies: Bullet-resistant sheathing and wallboard for bullet-resistant partitions and walls.

1.03 SUBMITTALS

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

B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

D. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.

E. Samples: Submit two samples of door construction, 8 by 10 inches in size cut from top corner of door.

F. Samples: Submit two samples of door veneer, 8 by 10 inches in size illustrating wood grain, stain color, and sheen.

G. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

H. Manufacturer's Installation Instructions: Indicate special installation instructions.

I. Manufacturer's qualification statement.

J. Installer's qualification statement.

K. Warranty, executed in Owner's name.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package, deliver and store doors in accordance with specified quality standard.

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.

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide manufacturer's warranty on interior doors for the life of the installation. Complete forms in Owner's name and register with manufacturer.

1. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Wood Veneer Faced Doors:

1. Masonite Architectural; Aspiro Select Wood Veneer Doors: www.architectural.masonite.com/#sle.
2. Oregon Door: www.oregondoor.com/#sle.
3. VT Industries, Inc: www.vtindustries.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 DOORS AND PANELS

A. Doors: See drawings for locations and additional requirements.

B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.

1. Provide solid core doors at each location, as noted on the door schedule in the drawings.

2.03 DOOR AND PANEL CORES

A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.

2.04 DOOR FACINGS

A. Veneer Facing for Transparent Finish: White oak, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.

1. Vertical Edges: Any option allowed by quality standard for grade.
2. "Pair Match" each pair of doors; "Set Match" pairs of doors within 10 feet of each other when doors are closed.

2.05 DOOR CONSTRUCTION

A. Fabricate doors in accordance with door quality standard specified.

B. Cores Constructed with stiles and rails:

1. Provide solid blocks at lock edge for hardware reinforcement.
2. Provide solid blocking for other throughbolted hardware.

C. Where supplementary protective edge trim is required, install trim after veneer facing has been applied full-width.

D. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.

E. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.

F. Provide edge clearances in accordance with the quality standard specified.

2.06 FINISHES - WOOD VENEER DOORS

A. Finish work in accordance with WDMA I.S. 1A for grade specified and as follows:

1. Transparent:

a. Manufacturers standard, in compliance with performance duty level indicated.
b. Stain: As selected by Architect.
c. Sheen: Satin.

B. Factory finish doors in accordance with sample to be provided.

C. Seal door top edge with color sealer to match door facing.

2.07 ACCESSORIES

A. Hollow Metal Door Frames: See Section 081113.

B. Glazed Openings:

1. Heat-Strengthened and Fully Tempered Glass: ASTM C1048.
2. Tint: Clear.

C. Door Window Frames: Door window frames with glazing securely fastened within door opening.

1. Size: As indicated on drawings.
2. Frame Material: 18 gauge, 0.0478 inch, galvanized steel.
3. Metal Finish: Beige polyester powder coating.
4. Glazing: 1/4 inch thick, tempered glass, in compliance with requirements of authorities having jurisdiction.

D. Glazing: See Section 088000.

E. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.

F. 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 standard.

B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.

C. Use machine tools to cut or drill for hardware.

D. Coordinate installation of doors with installation of frames and hardware.

E. Coordinate installation of glazing.

3.03 TOLERANCES

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

B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

A. Adjust doors for smooth and balanced door movement.

B. Adjust closers for full closure.

END OF SECTION 081416

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SECTION 083100 - ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall- and ceiling-mounted access units.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 099123 - Interior Painting: Field paint finish.

1.03 SUBMITTALS

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

B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

D. Shop Drawings: Indicate exact position of each access door and/or panel unit.

E. Samples: Submit two access units, 12 by 12 inches in size indicating frame configuration .

F. Manufacturer's Installation Instructions: Indicate installation requirements.

G. Manufacturer's qualification statement.

H. Installer's qualification statement.

I. Project Record Documents: Record actual locations of each access unit.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

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

PART 2 PRODUCTS

2.01 ACCESS DOORS AND PANELS ASSEMBLIES

A. Wall-Mounted Units in Wet Areas:

1. Size: 12 by 18 inches.
2. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
3. Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface flush with wall surface.

B. Ceiling-Mounted Units:

1. Location: As indicated on drawings.
2. Panel Material: Steel, hot-dipped zinc, or zinc-aluminum-alloy coated.
3. Size - Other Ceilings: 18 by 24 inches.
4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.

2.02 WALL- AND CEILING-MOUNTED ACCESS UNITS

A. Manufacturers:

1. Activar Construction Products Group, Inc. - JL Industries : www.activarcpg.com/#sle.
2. Concealed-Frame Access Panel: Activar/JL Industries CT.
3. Babcock-Davis: www.babcockdavis.com/#sle.
4. Nystrom, Inc; RW: www.nystrom.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to proceeding with this work.

B. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install frames plumb and level in openings, and secure units rigidly in place.

C. Position units to provide convenient access to concealed equipment when necessary.

END OF SECTION 083100

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SECTION 083323 - OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior coiling doors.

B. Electric operators and control stations.

C. Wiring from electric circuit disconnect to operators and control stations.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.

C. Section 087100 - Door Hardware: Cylinder cores and keys.

D. Section 260583 - Wiring Connections: Power to disconnect.

1.03 SUBMITTALS

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

B. Product Data: Provide general construction, electrical equipment, and component connections and details.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

D. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.

E. Samples: Two slats, 4 by 12 inches in size illustrating shape, color and finish texture.

F. Manufacturer's Installation Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.

G. Manufacturer's qualification statement.

H. Installer's qualification statement.

I. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

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

C. Products Requiring Electrical Connection: Listed and classified by ITS (DIR), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for purpose specified and indicated.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for roller shaft counterbalance assembly. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Overhead Coiling Metal Doors:

1. C.H.I. Overhead Doors; Model 6180: www.chiohd.com/#sle.
2. Overhead Door Corporation; Model 610 Rolling Service Door: www.overheaddoor.com/#sle.
3. The Cookson Company; Thermiser Max: www.cooksondoor.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 COILING DOORS

A. Exterior Coiling Doors: Steel slat curtain.

1. Capable of withstanding positive and negative wind loads of 20 psf without undue deflection or damage to components.

2. Sandwich Slats: Manufacturer's standard, with core of foamed-in-place polyurethane insulation; minimum R-value of 4.88.
3. Nominal Slat Size: 3 inches wide by required length.
4. Finish: Factory painted, color as selected by Architect.
5. Hood Enclosure: Manufacturer's standard; primed steel.
6. Electric operation.
7. Mounting: Surface mounted.

2.03 MATERIALS

A. Metal Curtain Construction: Interlocking slats.

1. Curtain Bottom for Slat Curtains: Fitted with angles to provide reinforcement and positive contact in closed position.
2. Weatherstripping for Exterior Doors: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.
3. Steel Slats: Minimum thickness, 20 gauge, 0.0359 inch; ASTM A653/A653M galvanized steel sheet.

B. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.

C. Guides - Angle: ASTM A36/A36M metal angles, size as indicated.

1. Prime painted.

D. Hood Enclosure and Trim: Internally reinforced to maintain rigidity and shape.

1. Minimum thickness; 24 gauge, Provide minimum 1/4 inch steel intermediate support brackets as required to prevent excessive sag.
2. Prime painted.

E. Lock Hardware:

1. For motor operated units, additional lock or latching mechanisms are not required.

F. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.04 ELECTRIC OPERATION

A. Operator, Controls, Actuators, and Safeties: Comply with UL 325; provide products listed by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction.

1. Provide interlock switches on motor operated units.

B. Electric Operators:

1. Mounting: Side mounted.
2. Motor Enclosure:
3. Motor Rating: 1/3 HP; continuous duty.
4. Motor Voltage: 120 volts, single phase, 60 Hz.
5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
6. Controller Enclosure: NEMA 250, Type 4.
7. Opening Speed: 12 inches per second.
8. Brake: Manufacturer's standard type, activated by motor controller.
9. Manual override in case of power failure.
10. See Section 260583 for electrical connections.

C. Control Station: Provide standard three button, 'Open-Close-Stop' momentary-contact control device for each operator complying with UL 325.

1. 24 volt circuit.

2. Surface mounted, at interior door jamb.
3. Entrapment Protection Devices: Provide sensing devices and safety mechanisms complying with UL 325.

a. Primary Device: Provide electric sensing edge, wireless sensing, NEMA 1 photo eye sensors, or NEMA 4X photo eye sensors as required with momentary-contact control device.

D. Safety Edge: Located at bottom of coiling door, full width, electro-mechanical sensitized type, wired to stop and reverse door direction upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that adjacent construction is suitable for door installation.

B. Verify that electrical services have been installed and are accessible.

C. Verify that door opening is plumb, header is level, and dimensions are correct.

D. Notify Architect of any unacceptable conditions or varying dimensions.

E. Commencement of installation indicates acceptance of substrate and door opening conditions.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with Section 260583.

F. Complete wiring from disconnect to unit components.

G. Install enclosure and perimeter trim.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation From Plumb: 1/16 inch.

C. Maximum Variation From Level: 1/16 inch.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 feet straight edge.

3.04 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. Clean installed components.

B. Remove labels and visible markings.

END OF SECTION 083323

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SECTION 084313 - ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior and Interior Aluminum-framed storefront systems, with vision glass.

B. Exterior and Interior Aluminum doors and frames with vision glass.

C. Weatherstripping.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

B. Section 051200 - Structural Steel Framing: Steel attachment members.

C. Section 055000 - Metal Fabrications: Steel attachment devices.

D. Section 072500 - Weather Barriers: Sealing framing to water-resistive barrier installed on adjacent construction.

E. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.

F. Section 087100 - Door Hardware: Hardware items other than specified in this section.

G. Section 088000 - Glazing: Glass and glazing accessories.

H. Section 122400 - Window Shades: Attachments to framing members.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

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

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.

C. Sustainable Design Submittals: Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC sealing compounds and adhesives.

D. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.

1. Include design engineer's stamp or seal on shop drawings for attachments and anchors.

E. Samples: Submit two samples 24 x 24 inches in size illustrating finished aluminum surface, glass, glazing materials.

F. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

G. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.

H. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

I. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

J. Manufacturer's qualification statement.

K. Installer's qualification statement.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

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

1.06 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional requirements.

B. Construct one exterior mock-up, full height long by minimum 8 feet wide, indicating selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

C. Locate where directed.

D. Mock-up may remain as part of work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

C. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Aluminum-Framed Storefronts:

1. Kawneer North America: www.kawneer.com/#sle.
2. YKK AP America, Inc: www.ykkap.com/commercial/#sle.
3. U.S. Aluminum; a brand of C.R. Laurence.: www.usalum.com.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 BASIS OF DESIGN – EXTERIOR FRAMING FOR 1" LOW-E INSULATING GLAZING

A. Front-Set Style, Structural Sealant Glazed Verticals, Thermally-Broken:

1. Basis of Design: Kawneer North America; Trifab Versaglaze 601UT SSG, Front Set, : www.kawneer.com/#sle.
2. Vertical Mullion Dimensions: 2 inches wide by 5-1/4 inches deep.

B. Substitutions: See Section 016000 - Product Requirements.

1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.03 BASIS OF DESIGN – INTERIOR FRAMING FOR MONOLITHIC GLAZING

A. Front-Set Style, Structural Sealant Glazed Verticals:

1. Basis of Design: Kawneer North America; Trifab Versaglaze 450, Front Set, : www.kawneer.com/#sle.
2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.

B. Substitutions: See Section 016000 - Product Requirements.

1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.04 BASIS OF DESIGN -- SWINGING DOORS

A. Exterior and Interior Entrance Doors, Wide Stile Widths:

1. Basis of Design: Kawneer North America; Trifab Versaglaze 601UT : www.kawneer.com/#sle.
2. Thickness: 1-3/4 inches.

B. Other Manufacturers: Provide either the product identified as "Basis of Design" or an equivalent product of of another manufacturer matching the storefront system. .

C. Substitutions: See Section 016000 - Product Requirements.

1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.05 ALUMINUM-FRAMED STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.

1. Glazing Rabbet:

a. For 1 inch insulating glazing.
b. For 1/4 inch and 3/8" monolithic glazing.

2. Finish: High performance organic coatings.

a. Factory finish all surfaces that will be exposed in completed assemblies.
b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

3. Finish Color: As selected by Architect from manufacturer's standard line.
4. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
5. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
6. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
7. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
8. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
9. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Performance Requirements

1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.

a. Positive Design Wind Load: As indicated on Drawings.
b. Negative Design Wind Load: As indicated on Drawings.
c. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.

2. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.

2.06 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, drainage holes and internal weep drainage system.

1. Glazing Stops: Flush.

B. Glazing: See Section 088000.

C. Swing Doors: Glazed aluminum.

1. Thickness: 1-3/4 inches.
2. Top Rail: 4 inches wide.
3. Vertical Stiles: Wide.
4. Bottom Rail: 10 inches wide.
5. Glazing Stops: Square.
6. Finish: Same as storefront.

2.07 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Fasteners: Stainless steel.

C. Concealed Flashings: Galvanized steel, 26 gauge, 0.0179 inch minimum base metal thickness.

D. Concealed Flashings: Sheet aluminum, 26 gauge, 0.017 inch minimum thickness.

E. Sill Flashing Sealant: Elastomeric, silicone or polyurethane, compatible with flashing material.

F. Sealant for Setting Thresholds: Non-curing butyl type.

G. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

H. Glazing Accessories: See Section 088000.

2.08 FINISHES

A. High Performance Organic Coating: AAMA 2604; multiple coats, thermally cured fluoropolymer system.

1. Basis-Of-Desing Product:

a. Sherwin-Williams Company; Powdura 4000: oem.sherwin-williams.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

B. Superior Performing Organic Coatings System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of aluminum extrusion and panels surfaces having minimum total dry film thickness (DFT) of 1.2 mils, 0.0012 inch.

1. Manufacturers:

a. PPG; Duranar: www.ppgmetalcoatings.com/#sle.
b. Sherwin-Williams Company; Fluropon: www.coil.sherwin.com/#sle.

c. Substitutions: See Section 016000 - Product Requirements.

C. Color: White.

D. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.09 HARDWARE

A. Other Door Hardware: See Section 087100.

B. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.

C. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.

D. Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.

H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

I. Install glass using glazing method required to achieve performance criteria; see Section 088000.

J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 FIELD QUALITY CONTROL

A. Provide services of storefront manufacturer's field representative to observe for proper installation of system and submit report.

B. See Section 014000 - Quality Requirements for general testing and inspection requirements.

C. Water-Spray Test: Provide water spray quality test of installed storefront components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.

1. Perform a minimum of two tests in each designated area as indicated on drawings.
2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.

D. Repair or replace storefront components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.05 ADJUSTING

A. Adjust operating hardware and sash for smooth operation.

3.06 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.07 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 084313

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SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Sliding doors.
3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Automatic operators.
4. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 01 Section "Sustainable Design Requirements – HPBS".
2. Division 08 Section "Hollow Metal Doors and Frames".
3. Division 08 Section "Flush Wood Doors".
4. Division 08 Section "Stile and Rail Wood Doors".
5. Division 08 Section "Sound Control Hollow Metal Door Assemblies".
6. Division 08 Section "Sound Control Wood Door Assemblies".
7. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
8. Division 08 Section "All-Glass Entrances".
9. Division 08 Section "Automatic Door Operators".
10. Division 28 Section "Access Control Hardware Devices".

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.

7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
8. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

1.4 Sustainable Design Submittals Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

   a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
   b. Complete (risers, point-to-point) access control system block wiring diagrams.
   c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified and authorized provider of the primary Integrated Wiegand Access Control Products.

E. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

F. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.

1.6 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Integrated Wireless, and IP-Enabled Access Control Products Supplier Qualifications: Integrated access control products and accessories are required to be supplied and installed through current members of the ASSA ABLOY "Authorized Channel Partner" (ACP) and "Certified Integrator" (CI) programs. Suppliers are to be factory trained, certified prior to project bid, and a direct purchaser of the specified product. Installers are to be factory trained, certified prior to project bid, and are responsible for commissioning, servicing, and warranting the installed equipment specified for the project.

F. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

G. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

H. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.

3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

I. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

J. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.7 DELIVERY, STORAGE AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.8 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.9 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Hardware shall not have any visible manufacturer names on exposed materials, except cylinders, when the door is in a closed position.

2.2 BUTT HINGES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.

c. Four Hinges: For doors with heights 91 to 120 inches.
d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for all out-swinging lockable doors.

5. Manufacturers:

a. McKinney (MK) - TA/T4A Series, 5-knuckle.

2.3 CONTINUOUS HINGES

A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:.

a. Pemko (PE).

2.4 POWER TRANSFER DEVICES

A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

    a. Pemko (PE) - EL-CEPT Series.
    b. Securitron (SU) - EL-CEPT Series.

B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

    a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
    b. McKinney (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

    a. McKinney (MK) - QC-C Series.

2.5 DOOR OPERATING TRIM

A. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Pulls, where applicable, shall be provided with a 10" clearance from the finished floor on the push side to accommodate wheelchair accessibility.
5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets. When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.
6. Manufacturers:

    a. Rockwood (RO).

2.6 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Manufacturer's Standard.

C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. New System: Key locks to a new key system as directed by the Owner.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.7 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

a. Lund Equipment (LU).

b. MMF Industries (MM).
c. Telkee (TK).

P. Electronic Key Management System: Provide an electronic key control system with Stand-alone Plug and Play features including advanced RFID technology. Touchscreen interface with PIN access for keys individually locked in place. Minimum 1,000 system users and 21 iFobs for locking receptors. System shall have a minimum 250,000 audit events screen displayed or ability to be exported via USB port.

1. Manufacturers:

a. Medeco (MC).

2.8 MORTISE LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Manufacturers:

a. dormakaba BEST (BE) - 45H Series.
b. Sargent Manufacturing (SA) - 8200 Series.

2.9 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.10 ELECTRIC STRIKES

A. Standard Electric Strikes: Electric strikes conforming to ANSI/BHMA A156.31, Grade 1, for use on non-rated or fire rated openings. Strikes shall be of stainless steel construction

tested to a minimum of 1500 pounds of static strength and 70 foot-pounds of dynamic strength with a minimum endurance of 1 million operating cycles. Provide strikes with 12 or 24 VDC capability, fail-secure unless otherwise specified. Where specified provide latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike.

1. Manufacturers:

    a. HES (HS) - 1500/1600 Series.

B. Tubular Exit Device Electric Strikes: Provide electric strikes designed to work with tubular exit devices that conform to ANSI A156.31, Grade 1. Electric strikes shall be of stainless-steel construction with field selectable fail safe/fail secure and dual 12/24 VDC. Provide lock monitor when specified.

1. Manufacturers:

    a. HES (HS) - 9100/9200 Series.

C. Provide electric strikes with in-line power controller and surge suppressor by the same manufacturer as the strike with the combined products having a five year warranty.

2.11 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.
2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.

1. Provide exit devices with functions and features as follows:

    a. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
    b. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.
    c. No catch points: addition of applied deflectors or other added components are not allowed.
    d. No visible plastic.
    e. Heavy duty end caps with flush and overlapping options made of stainless steel, brass, or bronze with architectural finishes.
    f. Constructed of all stainless steel.
    g. Stainless steel pullman type latch with deadlock feature.
    h. Narrow or wide style exterior trim as specified in the hardware sets.
    i. Center case adjustability on concealed vertical rod exit devices; single operation with hex key individually adjusts top or bottom latches. No retainer screws or clips required to maintain adjustment.
    j. Ten-year limited warranty for mechanical features.

2. Electromechanical exit devices shall have the following functions and features:

    a. Universal Molex plug-in connectors that have standardized color-coded wiring and are field configurable in fail safe or fail secure and operate from 12vdc to 24vdc regulated.
    b. Wire routing for all non-access control electromechanical functions and EcoFlex trim to be contained within the carrier of the device eliminating the need for cavities in doors to be drilled. Include a protective film so that wires don't get damaged if the rail needs to be removed.
    c. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
    d. Options to be available for request-to-exit or enter signaling, latchbolt and touchbar monitoring.
    e. Field configurable electrified trim to fail-safe or fail-secure that operates from 12-24VDC.

3. Manufacturers:

    a. Sargent Manufacturing (SA) - PE80 Series.
    b. Von Duprin (VD) - 35A/98 XP Series.

C. Tubular Panic Devices: ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Device to be ADA compliant requiring less than 5 lbs. of force to activate. Post mounting with optional mechanical dogging. Provide proper fasteners as required by manufacturer to meet application requirements. Provide exit devices on both leaves of pairs of doors.

1. Style: Exposed vertical rod. 1-1/4" grip diameter with interior operating panic handle in combination with exterior fixed pull handle. Panic mechanism shall be concealed within brass or stainless steel tubing. Optional entrance from exterior by a keyed cylinder.
2. Configurations (provide as specified):
3. Push/pull operation when dogged from the inside.
4. Latching: Top latching. Reversed, flat, Pullman style. Roller-type latching not acceptable.
5. Engraved "PUSH" signage with optional paint infill and boundary grooves.
6. Manufacturers:

    a. Rockwood (RO) - PDU8500 Series.

2.12 SURFACE DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete

spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Heavy duty surface mounted door closers shall have a 30-year warranty.

2. Manufacturers:

   a. dormakaba (DO) - 8900 Series.
   b. Norton Rixson (NO) - 7500 Series.
   c. Sargent Manufacturing (SA) - 351 Series.

2.13 ELECTROMECHANICAL DOOR OPERATORS

A. Electromechanical Door Operators (High Traffic): Provide ANSI/BHMA A156.19 Certified Products Directory (CPD) listed low energy operators that are UL325/991 and UL10C certified and comply with requirements for the Americans with Disabilities Act (ADA). Operators shall accommodate openings up to 250 pounds and 48" wide.

1. Provide operators with features as follows:

   a. Non-handed with push and pull side mounting.
   b. Activation by push button, hands-free or radio frequency devices.
   c. Adjustable opening force and closing power.
   d. Two-year limited warranty.
   e. Wi-Fi interface where the operator is a secure, password protected WiFi hot spot with no connection to building's IT required.
      1) Simple setup with no app required.
      2) View status and make adjustments without removing the cover.
      3) Built-in logic to support single use restroom applications with no external relay boards, logic modules, position switches required.
   f. Mounting backplate to simplify and speed up installation.
   g. Integration with access control systems.

2. Operators shall have the following functionality:

   a. Adjustable Hold Open: Amount of time a door will stay in the full open position after an activation.
   b. Blow Open for Smoke Ventilation: Door opens when signal is received from alarm system allowing air or smoke to flow through opening. Door will stay open until signal from alarm system is stopped.
   c. Emergency Interface Relay: Door closes and ignores any activation input until signal is discontinued.
   d. Infinite Hold Open: Door will hold open at set position until power is turned off.

e. Latch Assist: At closed position, after an activation, the door is pulled in. After the door has closed, the door is pulled in to assist with latch release/engagement.
f. Obstruction Detection: Door closes if it hits an obstruction while opening; door will reverse to open position if it hits an obstruction while closing. Door will stop once it hits an obstruction and will rest against the obstruction until removed.
g. Open Delay: Delays operator opening for locking hardware.
h. Outside Wall Switch Disable: When contact is closed, outside wall switch is disabled.
i. Power Assist: Senses the door is being opened manually and applies small amount of power to assist the user in opening the door with force less than 5 lbs. The door opens only as far as it is moved manually, then closes once released.
j. Power Close: Additional force to assist door closing between 7° and 2°.
k. Presence Detector Input: Input for external sensor to detect presence at door open or close position only.
l. Push & Go: As the door is manually opened, the operator "senses" movement and opens door to the full-open position.
m. Selector Mode Switch: Off disables the signal inputs unless Blow Open is activated, on activates the signal inputs, hold open activates the unit (unless Blow Closed is activated) to the hold open position.
n. Vestibule Delay: When the wall switch is pressed, first door in vestibule will open. Second door will open once vestibule door delay has expired. Delay is adjustable.
o. Executive Mode Feature: When the door receives an activation signal it opens and remains open until either a second signal is received, or the door is manually moved in closing direction.

3. Manufacturers:

a. ASSA ABLOY Entrance Systems (BE) - SW200 Series.

2.14 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.

4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:

    a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:

    a. Rockwood (RO).

2.15 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

    a. Rockwood (RO).

2.16 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. Pemko (PE).

2.17 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.18 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Integrated Wiegand access control products are required to be installed through current members of the ASSA ABLOY "Certified Integrator" (CI) program.

D. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

E. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.

F. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

G. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

B. Fire Door Assembly Inspection: Reference Division 01 Sections "Closeout Procedures". Conduct an initial fire door assembly inspection, including documentation reporting, upon completion of door hardware installation according to NFPA 80 Standard for Fire Doors and Other Opening Protectives, paragraph 5.2.4, requirements.

3.5 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.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should 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 and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. SA - SARGENT
4. SU - Securitron
5. RO - Rockwood
6. DE - Detex Corporation
7. HS - HES
8. BM - Besam
9. NO - Norton
10. GS - ASSA ABLOY Glass Solutions
11. OT - Other

Hardware Sets

Set: 1.0
Doors: 100A, 100B

2	Continuous Hinge	10BEFM SLF-HD1-M		PE
1	Mortise Cylinder	21 41 GMK	US10BE	SA
1	Storefront Panic Device	PDU8500-3 04	10BE	RO
1	Storefront Panic Device	PDU8500-3	10BE	RO
1	Electric Strike	9200-LMS	613E	HS
1	Pair Door Operators	SW200i (surface pair)		BM
1	Gasketing	by door manufacturer		
2	Sweep	315DN		PE
1	Threshold	252x2-10BE-FG		PE
1	Frame Harness	QC-C1500P (as required)		MK
1	Request to Exit	provided by division 28		SU
2	Push Plate Actuator	505		NO
1	Power Supply	AQL Series (as required) provided by division 28		SU
2	Door Position Switch	provided by division 28		OT
1	Card Reader	provided by division 28		

Notes: Door normally closed and locked or left unlocked through the access control system.
Entrance by valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Actuator button initiates automatic operator inside or outside, except when locked.
Door monitored for door ajar and forced open.

Set: 2.0
Doors: 100C, 100D

2	Continuous Hinge	10BEFM SLF-HD1-M		PE
2	Pull	DDU8000-3	10BE	RO
1	Pair Door Operators	SW200i (surface pair)		BM
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	by door manufacturer		
2	Sweep	315DN		PE
1	Threshold	271-10BE (or per detail)		PE
2	Push Plate Actuator	505		NO

Set: 3.0
Doors: 113A

1	Continuous Hinge	10BEFM SLF-HD1-M		PE
1	Mortise Cylinder	21 41 GMK	US10BE	SA
1	Storefront Panic Device	PDU8500-3 04	10BE	RO
1	Electric Strike	9100L-LMS	613E	HS
1	Single Door Operator	SW200i (surface single)		BM
1	Gasketing	by door manufacturer		
1	Sweep	315DN		PE
1	Threshold	252x2-10BE-FG		PE
1	Frame Harness	QC-C1500P (as required)		MK
1	Request to Exit	provided by division 28		SU
2	Push Plate Actuator	505		NO
1	Power Supply	AQL Series (as required) provided by division 28		SU
1	Door Position Switch	provided by division 28		OT
1	Card Reader	provided by division 28		

Notes: Door normally closed and locked or left unlocked through the access control system.
Entrance by valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Actuator button initiates automatic operator inside or outside, except when locked.
Door monitored for door ajar and forced open.

Set: 4.0
Doors: 113B

1	Continuous Hinge	10BEFM SLF-HD1-M		PE
1	Pull	DDU8000-3	10BE	RO
1	Single Door Operator	SW200i (surface single)		BM
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	by door manufacturer		
1	Sweep	315DN		PE
1	Threshold	271-10BE (or per detail)		PE
2	Push Plate Actuator	505		NO

Set: 5.0
Doors: 105B, 129, 201B, 301D, 402B, 413B, 508C

1	Continuous Hinge	10BEFM SLF-HD1-M PT		PE	
1	Electric Power Transfer	EL-CEPT	613E	SU	⚡
1	Rim Exit Device, Storeroom	21 55 56 PE8804 862 GMK	US10BE	SA	⚡
1	Surface Closer	351 CPS	US10BE	SA	
1	Drop Plate and Brackets/Spacers	as required			
1	Gasketing	by door manufacturer			
1	Sweep	315DN		PE	
1	Threshold	252x2-10BE-FG		PE	
1	Frame Harness	QC-C1500P (as required)		MK	⚡
1	Door Harness	QC-C__P (as required)		MK	⚡
1	Power Supply	AQL Series (as required) provided by division 28		SU	⚡
1	Door Position Switch	provided by division 28		OT	
1	Card Reader	provided by division 28			

Notes: Door normally closed and locked.
Entrance by presenting a valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Door monitored for door ajar and forced open.

Set: 6.0
Doors: 200C, 300C

1	Continuous Hinge	10BEFM SLF-HD1-M PT		PE	
1	Electric Power Transfer	EL-CEPT	613E	SU	⚡
1	Rim Exit Device, Exit Only	AL 21 PE8810 EO	US10BE	SA	⚡
1	Surface Closer	351 CPS	US10BE	SA	
1	Drop Plate and Brackets/Spacers	as required			
1	Wiring Harness	546		SA	
1	Gasketing	by door manufacturer			
1	Power Supply	9v DC Power Supply provided by division 28		SA	⚡
1	Sweep	315DN		PE	
1	Threshold	252x2-10BE-FG		PE	
1	Door Position Switch	provided by division 28		OT	

Notes: Door normally closed and locked.
No exterior access.
Alarmed egress at all times.

Set: 7.0
Doors: 113C

1	Continuous Hinge	10BEFM HD1-M PT		PE	
1	Electric Power Transfer	EL-CEPT	613E	SU	⚡
1	Fail Secure Exit Device	21 55 PE8876 NEMD GMK	US10BE	SA	⚡
1	Surface Closer	351 CPS	US10BE	SA	
1	Kick Plate	K1050 10" CSK BEV	10BE	RO	
1	Gasketing	2891-10BE-S		PE	
2	Gasketing	290-10BE-S		PE	
1	Door Bottom	216DFG		PE	

1	Threshold	273x3-10BE-FG		PE
1	Frame Harness	QC-C1500P (as required)		MK
1	Door Harness	QC-C__P (as required)		MK
1	Power Supply	AQL Series (as required) provided by division 28		SU
1	Door Position Switch	provided by division 28		OT
1	Card Reader	provided by division 28		

Notes: Door normally closed and locked.
Entrance by presenting a valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Door monitored for door ajar and forced open.

Set: 8.0
Doors: 01, 02

1	Rim Exit Device	V40 Series Exit Only Alarmed Panic		DE
1	Balance of Hardware	by door manufacturer		

Set: 9.0
Doors: 122B, 124B, 309B

1	Continuous Hinge	10BEFM HD1-M PT		PE
1	Fail Secure Lock	RX 21 8271 LNMD GMK	US10BE	SA
1	Electric Power Transfer	EL-CEPT	613E	SU
1	Surface Closer	351 CPS	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Gasketing	2891-10BE-S		PE
2	Gasketing	290-10BE-S		PE
1	Door Bottom	216DFG		PE
1	Threshold	273x3-10BE-FG		PE
1	Frame Harness	QC-C1500P (as required)		MK
1	Door Harness	QC-C__P (as required)		MK
1	Power Supply	AQL Series (as required) provided by division 28		SU
1	Door Position Switch	provided by division 28		OT
1	Card Reader	provided by division 28		

Notes: Door normally closed and locked.
Entrance by presenting a valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Door monitored for door ajar and forced open.

Set: 10.0
Doors: 125

3	Hinge	T4A3386 x NRP	US10BE(SS)	MK
1	Storeroom/Closet Lock	21 8204 LNMD GMK	US10BE	SA
1	Surface Closer	351 CPS	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO

1	Gasketing	2891-10BE-S		PE
2	Gasketing	290-10BE-S		PE
1	Door Bottom	216DFG		PE
1	Threshold	273x3-10BE-FG		PE

Notes:

Set: 11.0
Doors: 200A, 300A, 400A, 500A

1	Continuous Hinge	10BEFM SLF-HD1-M		PE
1	Mortise Cylinder	21 41 GMK	US10BE	SA
1	Storefront Panic Device	PDU8500-3 04	10BE	RO
1	Surface Closer	351 P10	US10BE	SA
1	Electric Strike	9100L-LMS	613E	HS
1	Drop Plate and Brackets/Spacers	as required		
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	by door manufacturer		
1	Frame Harness	QC-C1500P (as required)		MK
1	Request to Exit	provided by division 28		SU
1	Power Supply	AQL Series (as required) provided by division 28		SU
1	Door Position Switch	provided by division 28		OT
1	Card Reader	provided by division 28		

Notes: Door normally closed and locked.
Entrance by presenting a valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Door monitored for door ajar and forced open.

Set: 12.0
Description: NOT USED

1	Continuous Hinge	10BEFM SLF-HD1-M		PE
1	Mortise Cylinder	21 41 GMK	US10BE	SA
1	Surface Closer	351 P10	US10BE	SA
1	Electric Strike	INSFL-1600	10BE	RO
1	Locking Pull	INSFL3301DBU	10BE	RO
1	Drop Plate and Brackets/Spacers	as required		
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	by door manufacturer		
1	Frame Harness	QC-C1500P (as required)		MK
1	Power Supply	AQL Series (as required) provided by division 28		SU
1	Door Position Switch	provided by division 28		OT
1	Card Reader	provided by division 28		

Notes: Door normally closed and locked.
Entrance by presenting a valid credential to card reader.
Egress allowed at all times by turning thumb turn.

Loss of power maintains security from lock side, entrance by mechanical key only.
Door monitored for door ajar and forced open.

Set: 13.0
Doors: 103A

1	Continuous Hinge	10BEFM SLF-HD1-M PT		PE	
1	Electric Power Transfer	EL-CEPT	613E	SU	⚡
1	Rim Exit Device, Passage	54 56 PE8815 NEMD	US10BE	SA	⚡
1	Magnetic Lock	DEM680E	613E	SU	⚡
1	Single Door Operator	SW200i (surface single)		BM	⚡
1	Door Stop	406/409/441H (type as required)	10BE	RO	
1	Gasketing	by door manufacturer			
1	Request to Exit	provided by division 28		SU	⚡
2	Push Plate Actuator	505		NO	⚡
1	Pushbutton	EEB (type as required)		SU	⚡
1	Power Supply	AQL Series (as required) provided by division 28		SU	⚡
1	Card Reader	provided by division 28			

Notes: Door normally closed with delayed egress exit device.
Exterior access from lever trim on pull side at all times. Turning lever will release delayed egress maglock and provide request to exit signal to access control system.
Authorized egress by presenting valid credential to inside reader, momentarily inhibiting delayed egress exit device.
Delayed egress by pushing on exit device rail which initiates an irreversible local alarm and 15 second delay, after which door is free for egress.
Delayed egress exit device is tied to buildings fire alarm system and releases during alarm/power loss for immediate egress.

Set: 14.0
Doors: 200B, 300B

1	Continuous Hinge	10BEFM SLF-HD1-M		PE	
1	Storefront Panic Device	PDU8500	10BE	RO	
1	Surface Closer	351 P10	US10BE	SA	
1	Drop Plate and Brackets/Spacers	as required			
1	Door Stop	406/409/441H (type as required)	10BE	RO	
1	Gasketing	by door manufacturer			
1	Request to Exit	provided by division 28		SU	⚡
1	Strike	MSK-SGL	10BE	GS	
1	Door Position Switch	provided by division 28		OT	

Notes: Opening monitored for door status.

Set: 15.0
Doors: 201C, 301A, 402A, 413A, 500B, 500C, 508A, 508B

4	Hinge	T4A3786 x NRP	US10BE	MK	
1	Electric Power Transfer	EL-CEPT	613E	SU	⚡

1	Rim Exit Device	21 SN210-PE8876 BIPS-0E NEMD GMK (provided by division 28)		
	US10BE	SA		
1	Surface Closer	351 P10	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Gasketing	S44D		PE
1	Frame Harness	QC-C1500P (as required)		MK
1	Door Harness	QC-C__P (as required)		MK
1	Power Supply	AQL Series (as required) provided by division 28		SU

Notes: Door normally closed and locked.
Entrance by presenting a valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Door monitored for door ajar and forced open.

The card reader lock/exit device is provided by the division 28 security contractor.

Integrated lock includes request to exit and door position switch.

Set: 16.0
Doors: 111A, 111B

4	Hinge	T4A3786 (NRP as required)	US10BE	MK
1	Rim Exit Device, Storeroom	21 PE8804 NEMD GMK	US10BE	SA
1	Surface Closer	351 CPS	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Gasketing	S44D		PE

Set: 17.0
Doors: 123A

1	Continuous Hinge	10BEFM HD1-M PT		PE
1	Access Control Mort Lock	21 SN210-82271 BIPS-0E LNMD GMK (provided by division 28)		
	US10BE	SA		
1	Electric Power Transfer	EL-CEPT	613E	SU
1	Surface Closer	351 O/P9	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	S44D		PE
1	Frame Harness	QC-C1500P (as required)		MK
1	Door Harness	QC-C__P (as required)		MK
1	Power Supply	AQL Series (as required) provided by division 28		SU

Notes: Door normally closed and locked.
Entrance by presenting a valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Door monitored for door ajar and forced open.

The card reader lock/exit device is provided by the division 28 security contractor.

Integrated lock includes request to exit and door position switch.

Set: 18.0
Doors: 105A, 122A, 201A, 207, 214A, 214B, 215, 301B, 301C, 301E, 304, 305, 400B, 503B

4	Hinge	T4A3786 x NRP	US10BE	MK
1	Access Control Mort Lock US10BE	21 SN210-82271 BIPS-0E LNMD GMK (provided by division 28) SA		
1	Electric Power Transfer	EL-CEPT	613E	SU
1	Surface Closer	351 O/P9	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	S44D		PE
1	Frame Harness	QC-C1500P (as required)		MK
1	Door Harness	QC-C__P (as required)		MK
1	Power Supply	AQL Series (as required) provided by division 28		SU

Notes: Door normally closed and locked.
Entrance by presenting a valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Door monitored for door ajar and forced open.

The card reader lock/exit device is provided by the division 28 security contractor.

Integrated lock includes request to exit and door position switch.

Set: 19.0
Doors: 110

4	Hinge	T4A3786 x NRP	US10BE	MK
1	Access Control Mort Lock US10BE	21 SN210-82271 BIPS-0E LNMD GMK (provided by division 28) SA		
1	Electric Power Transfer	EL-CEPT	613E	SU
1	Surface Closer	351 CPS	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	S44D		PE
1	Frame Harness	QC-C1500P (as required)		MK
1	Door Harness	QC-C__P (as required)		MK
1	Power Supply	AQL Series (as required) provided by division 28		SU

Notes: Door normally closed and locked.
Entrance by presenting a valid credential to card reader.
Egress allowed at all times.
Loss of power maintains security from lock side, entrance by mechanical key only.
Door monitored for door ajar and forced open.

The card reader lock/exit device is provided by the division 28 security contractor.

Integrated lock includes request to exit and door position switch.

Set: 20.0
Doors: 119, 202, 205, 208, 211, 212, 213, 302, 303, 307, 308, 412, 414, 415, 416, 504, 505, 506, 511, 512, 513, 515, 516, 517, 518, 519, 520, 521, 522, 523

4	Hinge	T4A3786 (NRP as required)	US10BE	MK
1	Classroom Lock	21 8237 LNMD GMK	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	S44D		PE

Set: 21.0
Doors: 112A, 120, 121, 204, 209, 309A, 410, 411, 510

4	Hinge	T4A3786 (NRP as required)	US10BE	MK
1	Classroom Lock	21 8237 LNMD GMK	US10BE	SA
1	Surface Closer	351 O/P9	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	S44D		PE

Set: 22.0
Doors: 102, 403

4	Hinge	T4A3786 (NRP as required)	US10BE	MK
1	Privacy Lock	LB V21 8266 LNMD	US10BE	SA
1	Electric Strike	1600-CDB-DLMS	613E	HS
1	ElectroLynx Adaptor	2004M		HS
1	SMART Pac Bridge Rectifier	2005M3		HS
1	Single Door Operator	SW200i (surface single)		BM
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Acoustic Seal Set	PEMKOSTCSET-1A	BL	PE
1	Frame Harness	QC-C1500P (as required)		MK
2	Push Plate Actuator	505		NO
1	Power Supply	AQL Series (as required) provided by division 28		SU

Notes: Door normally closed and unlock.
Outside door switch actives automatic operator.
Projecting deadbolt shunts inside and outside door switch, changes occupancy indicator status.
Retracting deadbolt activates inside door switch.
Exiting room resets outside door switch.

Set: 23.0
Doors: 106, 107, 114, 115, 116, 117, 417, 418

4	Hinge	T4A3786 (NRP as required)	US10BE	MK
1	Privacy Lock	LB V21 8266 LNMD	US10BE	SA

1	Surface Closer	351 O/P9	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Kick Plate	K1050 4" high CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Acoustic Seal Set	PEMKOSTCSET-1A	BL	PE

Set: 24.0
Doors: 118, 203, 404, 405, 406, 407, 408, 409, 419

4	Hinge	T4A3786 (NRP as required)	US10BE	MK
1	Passage Latch	8215 LNMD	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	S44D		PE

Set: 25.0
Doors: 112B, 112C, 126, 127, 130, 210, 401, 501, 503A

4	Hinge	T4A3786 (NRP as required)	US10BE	MK
1	Passage Latch	8215 LNMD	US10BE	SA
1	Surface Closer	351 O/P9 (type as required)	US10BE	SA
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	S44D		PE

Set: 26.0
Doors: 103, 104, 108, 109

4	Hinge	T4A3786 (NRP as required)	US10BE	MK
1	Push Pull	111x73C/73CL	10BE	RO
1	Single Door Operator	SW200i (surface single)		BM
1	Kick Plate	K1050 10" CSK BEV	10BE	RO
1	Kick Plate	K1050 4" high CSK BEV	10BE	RO
1	Door Stop	406/409/441H (type as required)	10BE	RO
1	Gasketing	S44D		PE
2	Push Plate Actuator	505		NO

Set: 27.0
Doors: 123B, 124A, 503C

1	Hardware	by door manufacturer

END OF SECTION 087100

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DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 088000 - GLAZING

A. PART 1 GENERAL

I. SECTION INCLUDES

1. Insulating glass units.
2. Glazing units.
3. Glazing films.
4. Glazing compounds.

II. RELATED REQUIREMENTS

1. Section 018113.14 – Sustainable Design Requirements – HPBS.
2. Section 072700 - Air Barriers.
3. Section 079200 - Joint Sealants: Sealants for other than glazing purposes.
4. Section 081416 - Flush Wood Doors: Glazed lites in doors.
5. Section 084313 - Aluminum-Framed Storefronts: Glazing provided as part of storefront assembly.
6. Section 088800 - Special Function Glazing: Security glazing.

III. SUBMITTALS

1. See Section 013000 - Administrative Requirements for submittal procedures.
2. Product Data on Insulating Glass Unit and Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
3. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
4. Sustainable Design Submittals: Include:
    i. Sustainable design requirements for recycled content.
    ii. Sustainable design requirements for regional materials.

iii. Sustainable design requirements for Low VOC sealing compounds and adhesives.

5. Samples: Submit two samples 12 by 12 inch in size of glass units.

6. Manufacturer's qualification statement.

7. Installer's qualification statement.

8. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

IV. QUALITY ASSURANCE

1. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

V. MOCK-UPS

1. See Section 014000 - Quality Requirements for additional requirements.

2. Provide mock-up of one storefront section, one exterior entrance and one interior entrance including glass and air barrier and vapor retarder seal.

3. Locate where directed.

4. Mock-ups may remain as part of the Work.

VI. FIELD CONDITIONS

1. Do not install glazing when ambient temperature is less than 40 degrees F.

2. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

VII. WARRANTY

1. See Section 017800 - Closeout Submittals for additional warranty requirements.

2. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

B. PART 2 PRODUCTS

I. MANUFACTURERS

1. Float Glass Manufacturers:

   a. Cardinal Glass Industries: www.cardinalcorp.com/#sle.
   b. Guardian Glass, LLC: www.guardianglass.com/#sle.
   c. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.
   d. Substitutions: See Section 016000 - Product Requirements.

II. PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

1. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.

   a. Design Pressure:

      i. Positive Design Pressure: As indicated on Drawings.
      ii. Negative Design Pressure: As indicated on Drawings.

   b. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
   c. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
   d. Glass thicknesses listed are minimum.

2. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.

   a. In conjunction with weather barrier related materials described in other sections, as follows:
      i. Air Barriers: See Section 072700.

3. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:

   a. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
   b. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
   c. Solar Optical Properties: Comply with NFRC 300 test method.

III. GLASS MATERIALS

1. Float Glass: Provide float glass based glazing unless otherwise indicated.

    a. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
    b. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
    c. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
    d. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.

2. Glazing Film WF1: Basis of Design Product: Solyx Decorative Films, SXJ-0579 Dual Cloud Gradiant, 60" roll, or comparable approved substitution.

IV. INSULATING GLASS UNITS

1. Manufacturers:

    a. Cardinal Glass Industries: www.cardinalcorp.com/#sle.
    b. Guardian Glass, LLC; SNX 62/27: www.guardianglass.com/#sle.
    c. Pilkington North America Inc: www.pilkington.com/na/#sle.Pilkington North America Inc: www.pilkington.com/na/#sle.
    d. Vitro Architectural Glass (formerly PPG Glass); Starphire: www.vitroglazings.com/#sle.

2. Insulating Glass Units: Types as indicated.

    a. Durability: Certified by an independent testing agency to comply with ASTM E2190.
    b. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
    c. Warm-Edge Spacers: Low-conductivity thermoplastic with desiccant warm-edge technology design.

        i. Spacer Width: As required for specified insulating glass unit.
        ii. Spacer Height: Manufacturer's standard.

    d. Spacer Color: Black.
    e. Edge Seal:

        i. Color: Black.

    f. Purge interpane space with dry air, hermetically sealed.

3. Type IG-1 - Insulating Glass Units, Basis of Design: Guardian Sunguard, Low-E Ultraclear Vision glass, double glazed.

    a. Applications: Exterior glazing unless otherwise indicated.

b. Space between lites filled with argon.
c. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum, tempered where required.

i. Tint: Clear.
ii. Coating: Low-E SNX 62/27 (passive type), on #2 surface.

d. Inboard Lite: Annealed float glass, 1/4 inch thick, minimum.

i. Tint: Clear.

e. Total Thickness: 1 inch.
f. Thermal Transmittance (U-Value), Summer - Center of Glass: 0.24, nominal.
g. Visible Light Transmittance (VLT): 48% percent, nominal.
h. Solar Heat Gain Coefficient (SHGC): 0.26, nominal.
i. Visible Light Reflectance, Outside: 11% percent, nominal, Inside: 13%.
j. Glazing Method: Wet/dry glazing method, preformed tape and sealant.
k. Spacer Color: Black.
l. Edge Seal:

i. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.

m. Color: Black.

V. GLAZING UNITS

1. Type G-2 - Monolithic Interior Vision Glazing:

a. Applications: Interior glazing unless otherwise indicated.
b. Glass Type: Annealed float glass, tempered where required.
c. Tint: Clear.
d. Thickness: 1/4 inch, nominal.
e. Visible Light Transmittance (VLT): 90% percent, nominal.
f. Solar Heat Gain Coefficient (SHGC): 0.87, nominal.
g. Glazing Method: Dry glazing method, gasket glazing.

2. Type G-3 - Monolithic Safety Glazing: Non-fire-rated.

a. Applications:

i. Glazed lites in doors, except fire doors.
ii. Glazed sidelights to doors, except in fire-rated walls and partitions.
iii. Other locations required by applicable federal, state, and local codes and regulations.
iv. Other locations indicated on drawings.

b. Glass Type: Fully tempered safety glass as specified.
c. Tint: Clear.

d. Thickness: 3/8 inch, nominal for interior butt glazing.
e. Visible Light Transmittance (VLT): 88 percent, nominal.
f. Glazing Method: Dry glazing method, gasket glazing.

VI. GLAZING COMPOUNDS

1. Type GC-2 - Butyl Sealant: Single component; ASTM C920 Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color.

2. Type GC-5 - Silicone Structural Sealant: Single component; neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.

VII. ACCESSORIES

1. Setting Blocks: Type recommended in writing by sealant or glass manufacturer.

2. Spacer Shims: Type recommended in writing by sealant or glass manufacturer.

3. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.

4. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

VIII. SOURCE QUALITY CONTROL

1. See Section 014000 - Quality Requirements for additional requirements.

2. Provide shop inspection and testing for Insulated Glazing Units glass.

C. PART 3 EXECUTION

I. VERIFICATION OF CONDITIONS

1. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.

2. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.

3. Verify that sealing between joints of glass framing members has been completed effectively.

4. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

II. PREPARATION

1. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.

2. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

3. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

III. INSTALLATION, GENERAL

1. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.

2. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.

3. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.

4. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.

5. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, and paint.

IV. INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

1. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.

2. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.

3. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.

4. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

V. INSTALLATION - WET/DRY GLAZING METHOD (PREFORMED TAPE AND SEALANT)

1. Application - Exterior Glazed: Set glazing infills from the exterior of the building.

2. Cut glazing tape to length and set against permanent stops, 3/16 inch below sight line. Seal corners by butting tape and dabbing with butyl sealant.

3. Apply heel bead of butyl sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete the continuity of the air and vapor seal.

4. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.

5. Rest glazing on setting blocks and push against tape and heel bead of sealant with sufficient pressure to attain full contact at perimeter of pane or glass unit.

6. Install removable stops, with spacer strips inserted between glazing and applied stops 1/4 inch below sight lines.

   a. Place glazing tape on glazing pane of unit with tape flush with sight line.

7. Fill gap between glazing and stop with sealant to depth equal to bite of frame on glazing, but not more than 3/8 inch below sight line.

8. Apply cap bead of sealant along void between the stop and the glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

VI. INSTALLATION - WET/DRY GLAZING METHOD (TAPE AND SEALANT)

1. Application - Interior Glazed: Set glazing infills from the interior of the building.

2. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch above sight line.

3. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.

4. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.

5. Install removable stops, spacer shims inserted between glazing and applied stops at 24 inch intervals, 1/4 inch below sight line.

6. Fill gaps between pane and applied stop with double-sided foam tape type sealant to depth equal to bite on glazing, to uniform and level line.

7. Carefully trim protruding tape with knife.

VII. INSTALLATION - STRUCTURAL SILICONE GLAZING

1. Application - Factory (Shop) Glazed: Follow basic guidelines of structural silicone glazing for glazing application.

a. Two-Sided Structural Strip Window: Glass with two sides structurally adhered to vertical mullions and horizontal sides and vertical ends captured in glazing pockets.

2. Provide design review of the glazing system and project details, adhesion testing, proper surface preparation, training and a quality service program.

3. Provide only structural silicone sealant, tested and manufactured for structural glazing.

VIII. FIELD QUALITY CONTROL

1. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.

2. Monitor and report installation procedures and unacceptable conditions.

IX. CLEANING

1. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

2. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.

3. Remove nonpermanent labels immediately after glazing installation is complete.

4. Clean glass and adjacent surfaces after sealants are fully cured.

5. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

X. PROTECTION

1. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.

2. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

XI. SCHEDULES

1. Interior Aluminum-Framed Storefront System Glazing: Glass Type G3, install glass using dry method, and with glass thickness as required to comply with performance requirements indicated in Section 084313.

2. Exterior Aluminum-Framed Storefront System Glazing: Glass Type IG-1, Insulated Glazing Units, Low-E. Install glass using dry method, and with glass thickness as required to comply with performance requirements indicated in Section 084313.

3. Flush Wood Door Glazing:

    a. Interior: Glass Type G2, 1/4 inch thick, tempered, install glass using wet method with Type GC- 5 glazing compound.

END OF SECTION 088000

SECTION 088800 - SPECIAL FUNCTION GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Laminated security glazing units.

B. Plastic sheet security glazing units.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, and special application requirements. Identify available colors.

C. Samples: Two , 12 by 12 inches in size.

D. Certificate: Certify that products of this section meet or exceed specified requirements.

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

G. Executed warranty.

H. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

1.04 QUALITY ASSURANCE

1.05 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional requirements.

B. Provide mock-up of 16 square feet including glass and accssories.

C. Locate where directed.

D. Mock-ups may remain as part of work.

1.06 FIELD CONDITIONS

A. Do not install glazing when ambient temperature is less than 40 degrees F.

B. Maintain minimum ambient temperature before, during, and 24 hours after installation of glazing compounds.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Laminated Glass: Provide 5-year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 GLASS MATERIALS

A. Laminated Glass: Float glass laminated in accordance with ASTM C1172.

1. Laminated Safety Glass: Comply with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.

2.02 LAMINATED SECURITY GLAZING UNITS

A. Type SG-1 - Security Glazing: Laminated glass, 3-ply.

1. Applications: Locations as indicated on drawings.
2. Tint: Clear.
3. Thickness: As required to meet performance criteria.
4. Outer Lite: Tempered glass.
5. Interlayer: Polyvinyl butyral (PVB), thickness as required to meet performance criteria.
6. Middle Lite: Tempered glass.
7. Interlayer, Inboard Side: Polyvinyl butyral (PVB), thickness as required to meet performance criteria.
8. Inside Lite: Tempered glass.
9. Performance Criteria:

a. Bullet Resistance: Pass UL 752 tests to comply with Level 1: 9 mm pistol, full metal copper jacket with lead core ballistic criteria and weapon description.

10. Thermal Transmittance (U-value), Summer - Center of Glass: 0.8, nominal.

2.03 PLASTIC SHEET SECURITY GLAZING UNITS

A. Type SP-1 - Laminated polycarbonate security glazing, 3-ply.

1. Applications: Locations as indicated on drawings.
2. Surface Burning Characteristics: Flame spread index (FSI)/smoke developed index (SDI) of Class A, 25/450, maximum, when tested in accordance with ASTM E84.
3. Tint: Clear, transparent.
4. Thickness: As required to meet performance criteria.
5. Width: 96 inches.
6. Outer Lite: Polycarbonate.
7. Interlayer: Polyurethane, thickness as required to meet performance criteria.
8. Middle Lite: Polycarbonate.
9. Interlayer, Inboard Side: Polyurethane, thickness as required to meet performance criteria.
10. Inside Lite: Polycarbonate.
11. Silicone abrasion-resistant coating for scratch resistance.
12. Performance Criteria:

    a. Bullet Resistance: Pass UL 752 tests to comply with Level 3: 44 magnum, lead semi-wadcutter gas checked ballistic criteria and weapon description.

13. Glazing Method: As required to meet performance criteria.
14. Manufacturers:

    a. Isoclima Specialty Glass, LLC; LEXGARD SP 1250: www.isoclimasg.com/#sle.
    b. Total Security Solutions; LP1250-BR_L3.
    c. C.R. Laurance; LEXGARD3.
    d. Substitutions: See Section 016000 - Product Requirements.

2.04 ACCESSORIES

A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4-inch width of glazing rabbet space minus 1/16-inch height to suit glazing method and pane weight and area.

B. Drop-In Deal Tray: Non-Ricochet Level 3 Bullet Resistant

1. Size: 16" W x 12" D x 2" H

C. Speak - Thru:

1. Round Level 3 Clear: 10 inches
2. 3/4 inch standoff

2.05 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Provide shop inspection and testing for Type SP-1 glass.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.

B. Verify that surfaces of glazing channels or recesses are clean and free of obstructions that impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.

C. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.

B. Seal porous glazing channels or recesses with substrate-compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

A. Install glazing in accordance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.

B. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.

C. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.

D. Prevent glass from contact with contaminating substances resulting from construction including weld splatter, fire-safing, plastering, mortar droppings, and paint.

3.04 INSTALLATION - DRY GLAZING METHOD, GASKET GLAZING

A. Application: Set glazing infills from either exterior or interior of building.

B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.

C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.

D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 INSTALLATION - WET GLAZING METHOD, SEALANT AND SEALANT

A. Application - Exterior Glazed: Set glazing infills from exterior of building.

B. Place setting blocks at 1/4 points and install glazing pane or unit.

C. Install removable stops with glazing centered in space by inserting spacer shims on both sides at 24-inch intervals, 1/4 inch below sight line.

D. Fill gaps between glazing and stops with sealant to depth of bite on glazing, but not more than 3/8 inch below sight line to ensure full contact with glazing and continue air and vapor seal.

E. Apply sealant to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.06 INSTALLATION - WET/DRY GLAZING METHOD, TAPE AND SEALANT

A. Application - Interior Glazed: Set glazing infills from interior of building.

B. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch above sight line.

C. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.

D. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.

E. Install removable stops with spacer shims inserted between glazing and applied stops at 24-inch intervals, 1/4 inch below sight line.

F. Fill gaps between pane and applied stop with silicone sealant to depth equal to bite on glazing, to uniform and level line.

G. Carefully trim protruding tape with knife.

3.07 INSTALLATION - BUTT JOINT GLAZING METHOD, SEALANT ONLY

A. Application - Exterior Glazed: Set glazing infills from exterior side of building.

B. Temporarily brace glass in position for duration of glazing process; mask edges of glass at adjoining glass edges and between glass edges and framing members.

C. Temporarily secure small-diameter nonadhering foamed rod on back side of joint.

D. Apply sealant to open side of joint in continuous operation; thoroughly fill joint without displacing foam rod, and then tool sealant surface smooth to concave profile.

E. Permit sealant to cure, remove foam backer rod, apply sealant to opposite side, and tool smooth to concave profile.

F. Remove masking tape.

3.08 FIELD QUALITY CONTROL

A. Glass and Glazing: Product manufacturers provide field surveillance of installation of their products.

B. Monitor and report installation procedures and unacceptable conditions.

3.09 CLEANING

A. Remove excess glazing materials from finished surfaces immediately after application using solvents or cleaners recommended by manufacturers.

B. Remove nonpermanent labels immediately after glazing installation is complete.

C. Clean glass and adjacent surfaces after sealants are fully cured.

D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.10 PROTECTION

A. After installation, mark pane with 'X' using removable plastic tape or paste.

B. Remove and replace glass damaged during construction period prior to Date of Substantial Completion.

END OF SECTION 088800

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. Metal channel ceiling framing.

D. Acoustic insulation.

E. Gypsum sheathing.

F. Cementitious backing board.

G. Gypsum wallboard.

H. Joint treatment and accessories.

I. Bullet resistant sheathing and wallboard.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 018113.14 – Sustainable Design Requirements – HPBS.

C. Section 054000 - Cold-Formed Metal Framing: Structural steel stud framing.

D. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.

E. Section 072700 - Air Barriers: Air- and water-resistive barrier over sheathing.

F. Section 092216 - Non-Structural Metal Framing.

1.03 SUBMITTALS

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

B. Product Data:

1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.

C. Sustainable Design Submittals: Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC compounds and adhesives.

D. Samples: Submit two samples of predecorated gypsum board, 12 by 12 inches in size, indicating finish color and texture.

E. Test Reports: For stud framing products that do not comply with AISI S220 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

F. Ballistic Test Reports: Indicate compliance of bullet-resistant sheathing and wallboard assemblies with specified requirements.

G. Evaluation Service Reports: Show compliance of grid suspension systems with specified requirements.

H. Installer's Qualification Statement.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.

1.05 DELIVERY, STORAGE, AND HANDLING

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.

B. Interior Partitions, Indicated as Acoustic: 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.

C. Seismic Performance: Ceiling systems designed to withstand the effects of earthquake motions in accordance with ASCE 7 for Seismic Design Category D, E, or F and complying with the following:

D. Grid Suspension Systems: Provide grid suspension systems in accordance with ASTM C840 and GA-216 complying with the following:

1. ICC-ES Evaluation Report No. ESR-4358.

2.02 METAL FRAMING MATERIALS

A. Material and Product Requirements Criteria: AISI S201.

B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.

1. Structural Grade: As required to meet design criteria.

C. Nonstructural Steel Framing for Application of Gypsum Board: See Section 092216.

D. Structural Steel Framing for Application of Gypsum Board: See Section 054000.

E. Nonstructural Framing System Components: AISI S220; 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.

1. Studs: C-shaped with knurled or embossed faces.
2. Runners: U shaped, sized to match studs.
3. Ceiling Channels: C-shaped.

F. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as indicated on drawings.

G. Non-structural Framing Accessories:

1. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.

a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
b. Height: 35-3/4 inches.
c. Products:

1) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com/#sle.
2) Substitutions: See Section 016000 - Product Requirements.

2. Steel Column and Beam Drywall Clip: UL-listed slip-on clips to connect gypsum board to steel beams and columns for fireproofing.

    a. Products:

        1) Grabber Construction Products, Inc; CB60 : www.grabberpro.com/#sle.
        2) The Steel Network, Inc.; Gripclip: www.steelnetwork.com.
        3) Substitutions: See Section 016000 - Product Requirements.

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. PABCO Gypsum: www.pabcogypsum.com/#sle.
5. 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.
    b. Ceilings: 5/8 inch.
    c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.

3. Paper-Faced Products:

    a. Georgia-Pacific Gypsum; ToughRock: www.gpgypsum.com/#sle.
    b. USG Corporation; Sheetrock Brand EcoSmart Panels Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.

4. Glass Mat Faced Products:

    a. CertainTeed Corporation; 5/8" GlasRoc Interior Type X: www.certainteed.com/#sle.
    b. Georgia-Pacific Gypsum; DensArmor Plus: www.gpgypsum.com/#sle.
    c. USG Corporation; Sheetrock Brand Glass-Mat Panels Mold Tough Regular 5/8 in. (15.9 mm): www.usg.com/#sle.

C. 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. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Type: Regular, in locations indicated.

4. Regular Board Thickness: 5/8 inch.
5. Edges: Tapered.
6. Products:

    a. American Gypsum Company; M-Bloc: www.americangypsum.com/#sle.
    b. Georgia-Pacific Gypsum; ToughRock Mold-Guard Gypsum Board: www.gpgypsum.com/#sle.
    c. Georgia-Pacific Gypsum; DensArmor Plus: www.gpgypsum.com/#sle.
    d. USG Corporation; Durock Brand Glass-Mat Tile Backerboard 5/8 in. (15.9 mm): www.usg.com/#sle..
    e. Substitutions: See Section 016000 - Product Requirements.

D. Bullet Resistant Sheathing and Wallboard: Woven roving, multi-ply, ballistic grade fiberglass cloth with thermoset polyester resin; comply with UL 752 Level 1.

1. Thickness: 1/4 inch.
2. Products:

    a. ArmorCore by Waco Composites; Bullet Resistant Fiberglass Panels: www.armorcore.com/#sle.
    b. Covenant Security Equipment; Bullet Resistant Fiberglass Panels: www.covenantsecurityequipment.com.
    c. Fortified Estate, LLC; Bullet Resistant Fiberglass Panels – UL Level 1-8:www.fortifiedestate.com.
    d. Substitutions: See Section 016000 - Product Requirements.

E. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.

1. Application: Exterior sheathing, unless otherwise indicated.
2. Glass Mat Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
3. Core Type: Regular.
4. Regular Board Thickness: 1/2 inch.
5. Edges: Square.
6. Glass Mat Faced Products:

    a. American Gypsum Company; M-Glass Exterior Sheathing Type X: www.americangypsum.com/#sle.
    b. CertainTeed Corporation; GlasRoc Type X Exterior Sheathing: www.certainteed.com/#sle.
    c. Georgia-Pacific Gypsum; DensGlass Fireguard Sheathing: www.gpgypsum.com/#sle.
    d. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Sheathing: www.goldbondbuilding.com/#sle.
    e. USG Corporation; Securock Brand UltraLight Glass-Mat Sheathing Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.

2.04 GYPSUM BOARD ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness as required for STC.

B. Air Barrier: See Section 072700.

C. 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 OS-300: www.clarkdietrich.com/#sle.
3) Flannery, Inc; Corner Beads: www.flannerytrim.com/#sle.
4) Phillips Manufacturing Co; Everlast Corner Bead: www.phillipsmfg.com/#sle.
5) Trim-Tex, Inc: www.trim-tex.com/#sle.

2. Architectural Reveal Beads:

a. Shapes: As indicated on drawings.
b. Products: Fry Reglets, anodized or prefinished aluminum as indicated on drawings

D. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.

1. Fiberglass Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
2. Joint Compound: Setting type, field-mixed.

E. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.

F. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch 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 C1007AISI S220 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.

C. Studs: Space studs at 16 inches 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 extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.

D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

E. Blocking: Install wood blocking for support of:

1. Wall-mounted cabinets.
2. Plumbing fixtures.
3. Toilet partitions.
4. Toilet accessories.

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. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

1. Exception: Tapered edges to receive joint treatment at right angles to framing.

C. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.

D. Curved Surfaces: Apply gypsum board to curved substrates in accordance with GA-226.

E. Bullet Resistant Sheathing and Wallboard:

1. Install bullet-resistant sheathing according to manufacturer's written recommendations and with manufacturer-approved fasteners.
2. Cover all joints between boards with a 4-inch strip of the same thickness material as the boards, centered on the joint.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.

1. Not more than 30 feet apart on walls and ceilings over 50 feet long.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

D. Decorative Trim: Install at locations shown on drawings and in accordance with manufacturer's instructions.

3.06 JOINT TREATMENT

A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.

B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:

1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
3. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
4. Level 1: Wall areas above finished ceilings, whether or not accessible in the completed construction.

D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.

1. Feather coats of joint compound so that camber is maximum 1/32 inch.

E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

F. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.07 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.08 PROTECTION

A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION 092116

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SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal partition, ceiling, and soffit framing.

B. Framing accessories.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 054000 - Cold-Formed Metal Framing: Requirements for structural, load-bearing, metal stud framing and exterior wall stud framing.

C. Section 055000 - Metal Fabrications: Metal fabrications attached to stud framing.

D. Section 072100 - Thermal Insulation: Acoustic insulation.

E. Section 092116 - Gypsum Board Assemblies: Metal studs for gypsum board partition framing.

F. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, materials, sealants and adhesives.

C. Shop Drawings:

1. Indicate prefabricated work, component details, stud layout, framed openings, anchorage to structure, acoustic details, type and location of fasteners, accessories, and items of other related work.
2. Describe method for securing studs to tracks, splicing, and for blocking and reinforcement of framing connections.

D. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, and limitations.

E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

F. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.

2. Sustainable design requirements for regional materials.

3. Sustainable design requirements for Low VOC liquid finishes and sealing compounds.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience and approved by manufacturer.

B. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.

1.05 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional requirements.

B. Provide mock-up of stud wall, ceiling, and soffit framing including insulation, sheathing, window frame, and door frame and finish specified in other sections. Coordinate with installation of associated work specified in other sections.

1. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Framing, Connectors, and Accessories:

1. CEMCO: www.cemcosteel.com/#sle.
2. ClarkDietrich: www.clarkdietrich.com/#sle.
3. MarinoWARE: www.marinoware.com/#sle.
4. SCAFCO Corporation: www.scafco.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

2.02 FRAMING MATERIALS

A. Fire-Resistance-Rated Assemblies: Comply with applicable code and as follows:

1. Fire-Resistance-Rated Partitions: Listed assembly by UL, No. U465; 1 hour rating.

B. Loadbearing Studs: As specified in Section 054000.

C. Non-Loadbearing Framing System Components: AISI S220; sheet steel, of size and properties necessary for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.

1. Studs: C-shaped with flat faces.

a. Products:

1) CEMCO; CT Studs: www.cemcosteel.com/#sle.
2) ClarkDietrich; ProSTUD: www.clarkdietrich.com/#sle.
3) MarinoWARE; ViperStud Drywall Framing: www.marinoware.com/#sle.

2. Runners: U-shaped, sized to match studs.
3. Ceiling Channels: C-shaped.
4. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
5. Minimum Base-Steel Thickness: 0.0329 inch (0.84 mm).

D. Partition Head to Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and braced with continuous bridging on both sides.

E. Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.

1. Products:

a. ClarkDietrich; BlazeFrame Firestop Deflection Track: www.clarkdietrich.com/#sle.
b. MarinoWARE; FAS Track 1000: www.marinoware.com/#sle..
c. Substitutions: See Section 016000 - Product Requirements.

F. Non-Loadbearing Framing Accessories:

1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.

2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.

a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
b. Products:

1) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com/#sle.
2) Simpson Strong-Tie; RCKW Kneewall Connector: www.strongtie.com/#sle.
3) Substitutions: See Section 016000 - Product Requirements.

3. Fasteners: ASTM C1002 self-piercing self-tapping screws.
4. Anchorage Devices: Powder actuated.
5. Acoustic Insulation: See Section 072100.

2.03 FABRICATION

A. Fabricate assemblies of framed sections to sizes and profiles required.

B. Fit, reinforce, and brace framing members to suit design requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that rough-in utilities are in proper location.

3.02 INSTALLATION OF STUD FRAMING

A. Extend partition framing to structure where indicated and to ceiling in other locations.

B. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.

C. 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.

D. Align and secure top and bottom runners at 24 inches on center.

E. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.

F. Align stud web openings horizontally.

G. Secure studs to tracks using crimping method. Do not weld.

H. Fabricate corners using a minimum of three studs.

I. Install double studs at wall openings, door and window jambs, not more than 2 inches from each side of openings.

J. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.

K. Blocking: Use wood blocking secured to studs. Provide blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware, and opening frames.

L. Furring: Install at spacing and locations shown on drawings. Lap splices a minimum of 6 inches.

3.03 CEILING AND SOFFIT FRAMING

A. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.

B. Install furring independent of walls, columns, and above-ceiling work.

C. Securely anchor hangers to structural members or embed them in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.

D. Space main carrying channels at maximum 72 inches on center, and not more than 6 inches from wall surfaces. Lap splice securely.

E. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.

F. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.

3.04 TOLERANCES

A. Maximum Variation From True Position: 1/8 inch in 10 feet.

B. Maximum Variation From Plumb: 1/8 inch in 10 feet.

END OF SECTION 092216

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SECTION 093000 - TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Tile for floor applications.

B. Tile for wall applications.

C. Cementitious backer board as tile substrate.

D. Non-ceramic trim.

1.02 RELATED REQUIREMENTS

A. Section 018113 .14 – Sustainable Design Requirements – HPBS.

B. Section 079200 - Joint Sealants: Sealing joints between tile work and adjacent construction and fixtures.

C. Section 092116 - Gypsum Board Assemblies: Tile backer board.

D. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers.

1.04 SUBMITTALS

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

B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.

C. Sustainable Design Submittals Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC liquid treatments, coatings, sealants, materials and adhesives.

D. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, and setting details.

E. Samples: Mount tile and apply grout on two plywood panels, minimum 36 inches by 36 inches inches in size illustrating pattern, color variations, and grout joint size variations.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Master Grade Certificate: Submit for each type of tile, signed by the tile manufacturer and tile installer.

H. Installer's Qualification Statement:

1. Submit documentation of completion of apprenticeship and certification programs.

I. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.

J. 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: 5 percent of each size, color, and surface finish combination, but not less than 4 of each type.

K. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.

2. Sustainable design requirements for regional materials.

3. Sustainable design requirements for Low VOC liquid finishes and sealing compounds.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer Certification:

a. Advanced Certifications for Tile Installers (ACT): Certification in the installation of membranes, mortar bed (mud) floors, large format tile, and grouts.

1.06 MOCK-UPS

A. See Section 014000 - Quality Requirements for general requirements for mock-up.

B. Construct tile mock-up where indicated by architect, incorporating all components specified for the location.

1. Minimum size of mock-up to be 72 inches by 72 inches.
2. Approved mock-up may remain as part of work if approved by architec.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install solvent-based products in an unventilated environment.

B. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.

PART 2 PRODUCTS

2.01 TILE

A. Manufacturers: All products of each type by the same manufacturer. Obtain each tile type, color, and finish from the same production run to ensure consistent quality and appearance.

1. Mile Stone Tiles: www.milestonetiles.com/#sle.
2. Nemo Tile; nemotile.com.
3. Substitutions: See Section 016000 - Product Requirements.

B. Glazed Wall Tile, Type WT1: ANSI A137.1 standard grade.

1. Basis-of-Design Product: As indicated on drawing or an approved substitution.
2. Moisture Absorption: 7.0 to 20.0 percent as tested in accordance with ASTM C373.

C. Porcelain Tile, Type WT2: ANSI A137.1 standard grade.

1. Basis-of-Design Product: As indicated on drawings or an approved substitution.
2. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.

D. Gauged Porcelain Tiles and Panels/Slabs, Type TL1: ANSI A137.3 standard grade.

1. Basis-of-Design Product: As indicated on drawings or an approved substitution.
2. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.

2.02 TRIM AND ACCESSORIES

A. Non-Ceramic Trim: See drawings for color, style and dimensions as indicated on drawings, set with tile mortar or adhesive.

1. Applications:

a. Open edges of wall and floor tile.
b. Inside and outside wall corners.
c. Transition between floor finishes of different heights.
d. Thresholds at door openings.
e. Floor-to-wall joints.
f. Borders and other trim as indicated on drawings.

2. Products:

a. Basis of Design: Schluter-Systems; Schiene: www.schluter.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

2.03 SETTING MATERIALS

A. Provide setting and grout materials from same manufacturer.

B. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.

1. Applications: Use this type of bond coat where Large and Heavy Tile (LHT) mortar is indicated.
2. Products:

a. Custom Building Products; ProLite Premium Rapid Setting Large Format Tile Mortar, with Multi-Surface Bonding Primer: www.custombuildingproducts.com/#sle.
b. LATICRETE International, Inc; TRI-LITE: www.laticrete.com/#sle.
c. Mapei Corporation; Adesilex P10 Mosaic & Glass Tile: www.mapei.com/#sle.
d. Merkrete, by Parex USA, Inc; Merkrete 735 Premium Flex: www.merkrete.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.

C. Latex-Portland Cement Mortar Bond Coat (thin-set): ANSI A118.4.

1. Applications: Use this type of bond coat where small format tile, 12 inches or less in any direction are to be installed.
2. Products:

a. Custom Building Products; Versa Bond: www.custombuildingproducts.com/#sle.
b. LATICRETE International, Inc; 253 Gold Thinset Set Mortar: www.laticrete.com/#sle.
c. Mapei Corporation; Ultraflex 2 Thin Setd: www.mapei.com/#sle.
d. Merkrete Inc.: 7D10 Latex Thin Set Mortar.
e. Substitutions: See Section 016000 - Product Requirements.

2.04 GROUTS

A. Provide setting and grout materials from same manufacturer.

B. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.

1. Applications: Where indicated.
2. Color(s): As selected by Architect from manufacturer's full line.
3. Products:

a. Custom Building Products; CEG-IG 100% Solids Industrial Grade Epoxy Grout: www.custombuildingproducts.com/#sle.
b. LATICRETE International, Inc; LATICRETE SPECTRALOCK PRO Premium Grout: www.laticrete.com/#sle.
c. Mapei Corporation; Kerapoxy CQ: www.mapei.com/#sle.
d. Merkrete, by Parex USA, Inc; Merkrete Pro Epoxy: www.merkrete.com/#sle.
e. Substitutions: See Section 016000 - Product Requirements.

2.05 MAINTENANCE MATERIALS

A. Tile Sealant: Two-component, semi-rigid, 100 percent epoxy sealant; resistant to rolling loads.

1. Applications: Nonmoving and saw-cut control and construction joints in tile flooring.
2. Color: As selected by Architect from manufacturer's full line.
3. Products:

a. Mapei Corporation; Mapeflex Joint Filler EP 90/50: www.mapei.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

B. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.

1. Composition: Water-based colorless silicone.

C. Tile Sealer: Stain protection for ceramic tile tile.

1. Products: Basis-of-Design

a. Custom Building Products; Aqua Mix Enrich 'N' Seal: www.custombuildingproducts.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

D. Grout Release: Temporary, water-soluble pre-grout coating.

1. Products: Basis-of-Design

a. Custom Building Products; Aqua Mix Grout Release: www.custombuildingproducts.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

2.06 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 gap, minimum.
2. Bonded Sheet Membrane Type:

a. Material: Polyethylene sheet membrane with polyester fleece laminated to underside, 20 mils thick.
b. Products:

1) Schluter-Systems; DITRA: www.schluter.com/#sle.
2) Substitutions: See Section 016000 - Product Requirements.

B. Membrane at Walls:

1. Material: 4 mil thick polyethylene film.

C. Backer Board: Cementitious type complying with ANSI A118.9; high density, glass fiber reinforced, 5/8 inch thick; 2 inch wide coated glass fiber tape for joints and corners.

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.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.

C. Verify that subfloor surfaces are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces.

D. Cementitious Subfloor Surfaces: Verify that substrates are ready for tiling installation by testing for moisture and alkalinity (pH).

1. Obtain instructions if test results are not within limits recommended by tiling material manufacturer and setting material manufacturer.

E. Verify that required floor-mounted utilities are in correct location.

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.

E. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) or TCNA (HB-GP) recommendations, as applicable.

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. Install non-ceramic trim in accordance with manufacturer's instructions.

G. Install thresholds where indicated.

H. Sound tile after setting. Replace hollow sounding units.

I. Keep control and expansion joints free of mortar, grout, and adhesive.

J. Prior to grouting, allow installation to completely cure; minimum of 48 hours.

K. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.

L. 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. Use uncoupling membrane under all tile unless other underlayment is indicated.
2. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method F122, with latex-Portland cement grout.
3. Where epoxy bond coat and grout are indicated, install in accordance with TCNA (HB) Method F131.

B. Install tile-to-tile floor movement joints in accordance with TCNA (HB) Method EJ171F.

3.05 INSTALLATION - WALL TILE

A. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.

3.06 CLEANING

A. Clean tile and grout surfaces.

3.07 PROTECTION

A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION 093000

SECTION 095100 - ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

C. Supplementary insulation above ceiling.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers.

B. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

C. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

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

B. Shop Drawings: Indicate grid layout and related dimensioning.

C. Product Data: Provide data on suspension system components and acoustical units.

D. Sustainable Design Submittals Include:

   a. Sustainable design requirements for recycled content.
   b. Sustainable design requirements for regional materials.
   c. Sustainable design requirements for Low VOC materials, sealants and adhesives.

E. Samples: Submit two samples 6 inch by 6 inch in size illustrating material and finish of acoustical units.

F. Samples: Submit two samples each, 12 inches long, of suspension system main runner, cross runner, and perimeter molding.

G. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

H. Manufacturer's qualification statement.

I. 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.

1.05 QUALITY ASSURANCE

A. Designer Qualifications for Seismic Design: Perform under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the State in which the Project is located.

B. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acoustic Tiles/Panels: Basis-of-Deisgn as indicated on drawings.

1. Substitutions: See Section 016000 - Product Requirements.

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:

1. Local authorities having jurisdiction.

2.03 ACOUSTICAL UNITS

A. Acoustical Panels, Type ACT 1, ACT 2: Painted mineral fiber, with the following characteristics:

1. Classification: ASTM E1264 Type III.
2. Size: 24 by 24 inches and 24 by 48 inches.
3. Thickness: 3/4 inch.
4. Light Reflectance: 88 percent, determined in accordance with ASTM E1264.
5. NRC Range: .75 to .85, determined in accordance with ASTM E1264.
6. Articulation Class (AC): 170, determined in accordance with ASTM E1264.
7. Ceiling Attenuation Class (CAC): 40, determined in accordance with ASTM E1264.
8. Panel Edge: Square.
9. Tile Edge: Beveled.
10. Color: White.
11. Suspension System: Exposed grid.
12. Products: Basis-of-Design as indicated on drawings.

    a. Substitutions: See Section 016000 - Product Requirements.

B. Acoustical Panel Canopies, Type CC1: Reinforced lightweight multi-density panels suspended by hanger wire or rods attached to anchor points on panel back.

1. Size and Configuration: As indicated on drawings.
2. Thickness: 1 1/2 inches.
3. Finish: as indicated on drawings.
4. Products: Basis-of-Design as indicated on drawings.

    a. Substitutions: See Section 016000 - Product Requirements.

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. Exposed Suspension System, Type ACT1, ACT2: Hot-dip galvanized steel grid and cap.

1. Application(s): Seismic.
2. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.

3. Profile: Tee; 9/16 inch face width.
4. Finish: Baked enamel.
5. Color: White.
6. Products: Basis-of-Design as indicated on drawings

    a. Substitutions: See Section 016000 - Product Requirements.

C. Concealed Ceiling Suspension System: Aluminum grid.

1. Description: Engineered grid, with slotted faces in main tees, cross tees, hangers, trim molding, load resisting struts, hinge assemblies, and other suspension components required to support ceiling and other ceiling supported construction. Panels installed from below by inserting torsion springs into slots in faces of main tees of ceiling grid.
2. Application(s): Seismic.
3. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
4. Profile: Flat.
5. Finish: Powder coat.
6. 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 galvanized steel wire.

C. Hold-Down Clips: Manufacturer's standard clips to suit application.

D. Seismic Clips: Manufacturer's standard clips for seismic conditions and to suit application.

E. Perimeter Moldings: Same metal and finish as grid.

F. Metal Edge Trim for Suspension Systems: Steel or extruded aluminum; provide attachment clips, splice plates, and preformed corner pieces for complete trim system.

1. Trim Height: as indicated on drawings.
2. Finish: Baked enamel.
3. Color: White.

G. Ceiling Pockets with Prewired Raceway: UL 325 listed, extruded aluminum shade pocket with removable closure panel and acoustical unit support, for recess mounting in suspended acoustical or drywall ceilings; size and configuration as indicated on drawings.

1. Designed to accommodate installation of motor control and wiring accessories within pocket.

H. Acoustical Insulation: Specified in Section 072100.

I. Touch-up Paint: Type and color to match acoustical and grid units.

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 PREPARATION

A. Install after major above-ceiling work is complete.

B. Coordinate the location of hangers with other work.

C. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.

3.03 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Locate system on room axis according to reflected plan.

D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.

1. Use longest practical lengths.

E. 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.

F. 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 clearance between grid ends and wall.

G. 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.

H. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

I. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

J. Do not eccentrically load system or induce rotation of runners.

K. Form expansion joints as detailed. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.

3.04 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.

F. Install hold-down clips on panels within 20 ft of an exterior door.

3.05 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

B. Clean surfaces.

C. Replace damaged or abraded components.

END OF SECTION 095100

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SECTION 09 51 26 WOODWORKS VENEERED WALL PANELS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general conditions of Contract, including General and Supplementary Conditions and Divisions-1 Specification sections apply to work of this section.

1.2 SUMMARY

A. Section Includes:

1. WoodWorks Veneered Wall Panels

2. Installation components and finish accessories.

B. Related Sections:

1. Section 018113.14 – Sustainable Design Requirements – HPBS.

Section 09 29 00 - Gypsum Board

2. Divisions 23 (15) - HVAC

3. Division 26 (16) Sections - Electrical Work

C. Alternates

1. Prior Approval: Unless otherwise provided for in the Contract documents, submit proposed product substitutions no later than TEN (10) working days prior to the date established for receipt of bids. Acceptability of a proposed substitution is contingent upon the Architect's review and acceptance. Approved products will be set forth by the Addenda. If a substitution is included in a Bid and is not approved by an Addendum, the specified products shall be provided as in place of the substitute without additional compensation.

2. Submittals, which do not provide adequate data for the product evaluation, will not be considered. The proposed substitution must meet all requirements of this section, including but not necessarily limited to, the following: Single source materials suppliers (if specified in Section 1.5); panel design, size, composition, color, and finish; suspension system component profiles and sizes; compliance with the referenced standards.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
3. Hardwood Plywood & Veneer Association (HPVA)
4. International Building Code
5. ASHRAE Standard 62 1 2004 Ventilation for Acceptable Indoor Air Quality
6. NFPA 70 National Electrical Code
7. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures
8. California Air Resources Board (CARB) compliant
9. LEED - Leadership in Energy and Environmental Design is a set of rating systems for the design, construction, operation, and maintenance of green buildings

1.4 SUBMITTALS

A. Shop Drawings: Layout and details of walls. Show locations of items that are to be coordinated with or supported by the walls.

B. Installation Instructions: Submit manufacturer's installation instructions as referenced in Part three, Installation.

C. Product Data: Submit manufacturer's technical data for each type of wall unit and framing structure required.

B. D. Sustainable Design Submittals:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for low VOC coatings, materials and sealants.

D. Samples: Real Wood Veneer on fire rated particle board - Semi-gloss tinted topcoat – Clear Finish

E. Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards.

F. Non-Conformance: All products not conforming to the requirements of this specification and or the manufacturer's published values are to be disposed. The Contractor performing the work will replace with approved product at their expense.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide wall panel units and grid components by a single manufacturer.

B. Fire Performance Characteristics: Identify wall components with appropriate markings of applicable testing and inspecting organization.

1. Surface Burning Characteristics: As follows, tested per ASTM E-84 and complying with ASTM E 1264 for Class C products.

2. HPVA (Hardwood Plywood and Veneer Association) certification and audit program per ASTM E-84 tunnel test.

C. Woodworking Standards: Manufacturer must comply with specified provisions of Architectural Woodworking Institute quality standards.

D. Coordination of Work: Coordinate wall work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store wall components in a dry interior location in their cartons prior to installation to avoid damage. Store cartons in a flat, horizontal position. The protectors between the panels should not be removed until installation.

B. Do not store in unconditioned spaces with humidity greater than 55 percent or lower than 25 percent relative humidity and temperatures lower than 50 degrees F or greater than 86 degrees F. Panels must not be exposed to extreme temperatures, for example, close to a heating source or near a window with direct sunlight.

C. Handle wall units carefully to avoid chipped edges or damage to units in any way.

1.7 PROJECT CONDITIONS

A. Wood wall materials should be permitted to reach room temperature and have a stabilized moisture content for a minimum of 72 hours before installation. (Remove plastic wrap to allow panels to climatize).

B. The wood panels should not be installed in spaces where the temperature or humidity conditions vary from the temperatures and conditions that will be normal in the occupied space.

C. As interior finish products, the Veneered wood panels are designed for installation in temperature conditions between 50 degrees F and 86 degrees F, in spaces where the building is enclosed, and HVAC systems are functioning and will be in continuous operation. Relative humidity should not fall below 25 percent or exceed 55 percent.

1.8 WARRANTY

A. WW Grille Veneered Wall Panels: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to:

1. WW Veneered Wall Panels: Defects in materials or factory workmanship.

B. Warranty Period:

1. WW Veneered Wall Panels: One (1) year from date of installation.

C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.9 MAINTENANCE

A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.

1. Wall Units: Furnish quality of full-size units equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design WoodWorks Veneered Walls Panels:

1. Armstrong World Industries, Inc., Woodworks Wall Panels

2.2.0 WOOD WALL UNITS

A. Wall Panels Type W1:

1. Surface Texture: Smooth

2. Composition: Real wood veneer on unperforated fire rated particle board

3. Finish(s): Real Wood Veneer. Provide the following veneer sample for the final selection:

- White Maple (NMP)
- Cherry (NIC)
- Redux Wood Wheat (CRW)

Custom finishes available

4. Panel Size(s):

- 23 ¾ x 47 ¾ x ¾"

5. Suspension System options:

- 72" Z-Clip 5673

6. Flame Spread:

Class A: ASTM E84 surface burning characteristics. Flame Spread Index 25 or less. Smoke Developed Index 50 or less.

CAN/ULC S102 surface burning characteristics. Flame Spread Rating 25 or less. Smoke Developed Classification 50 or less.

2.2.1 SUSPENSION SYSTEMS

A. Refer to Armstrong WoodWorks Wall Panels Installation Instructions

B. Accessories and Perimeter Trim:

a. 5851 WoodWorks Walls Trim Peak Corner 126"

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out.

B. Proper designs for both supply air and return air, maintenance of the HVAC filters and building interior space are essential to minimize soiling. Before starting the HVAC system, make sure supply air is properly filtered and the building interior is free of construction dust.

3.2 PREPARATION

A. Measure each wall area and establish layout of acoustical units to balance border widths at opposite edges of each wall. Avoid use of less than half width units at borders and comply with wall elevations. Coordinate panel layout with mechanical and electrical fixtures.

B. WoodWorks wall materials should be permitted to reach room temperature and have a stabilized moisture content for a minimum of 72 hours before installation. (Remove plastic wrap to allow panels to climatize).

3.3 INSTALLATION

A. Interior WoodWorks products, the veneered wood panels are designed for installation in temperature conditions between 50 degrees F and 86 degrees F, in spaces where the building is enclosed, and HVAC systems are functioning and will be in continuous operation. Relative humidity should not fall below 25 percent or exceed 55 percent.

3.4 ADJUSTING AND CLEANING

A. Replace damaged and broken panels.

B. Clean exposed surfaces of walls panels, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage.

END OF SECTION

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SECTION 095426 -SUSPENDED WOOD CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wood veneer panels.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure ceilings are not installed until building is enclosed, dust generating activities have terminated, and overhead work is completed.

1.04 SUBMITTALS

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

B. See Section 018113 .14 – Sustainable Design Requirements – HPBS, include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC finishes and adhesives.

C. Shop Drawings: Indicate grid layout and related dimensioning, attachment of wood ceiling components to grid, accessory attachments, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.

D. Product Data: Provide data on wood ceiling components and suspension system components.

E. Product Data: Provide data on wood wall panels and attachment system.

F. Samples: Submit two 12 by 12 inch samples illustrating material and finish of wood ceiling components.

G. Samples: Submit two samples each, 12 inches long, of suspension system main runner, cross runner, and perimeter molding.

H. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

I. Manufacturer's qualification statement.

J. Installer's qualification statement.

K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements for additional provisions.
2. Wood Ceiling Components: Provide a quantity equal to 2 percent of total product installed.

1.05 QUALITY ASSURANCE

A. Designer Qualifications for Seismic Design: Perform design under direct supervision of Professional Structural Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood ceiling components to project site in original, unopened packages.

B. Store in fully enclosed space, flat, level and off the floor.

1.07 FIELD CONDITIONS

A. Do not install suspended wood ceiling system until wet construction work is complete and permanent heat and air conditioning is installed and operating.

B. Maintain room temperature between 60 degrees F and 75 degrees F and relative humidity between 35 to 55 percent before, during, and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 SUSPENDED WOOD CEILING SYSTEM

A. Performance Requirements:

1. Design for maximum deflection of 1/360 of span.

2. Design to resist seismic load by using practices specified in ASTM E580.

B. Wood Veneer Ceiling Panels, CC1: Composite wood core with wood veneer finish.

1. Basis of design product: Armstrong, Woodworks, Frameall Access Flat and Curved Ceiling Systems and Flat and Curved Drywall Grid, or comparable approved substitution.

    1. Factory Finish: Clear wood sealer, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Do not install ceiling until after interior wet work is dry.

3.02 PREPARATION

A. Coordinate the location of hangers with other work.

B. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.

C. Layout wood ceiling components in pattern according to reflected ceiling plan and as shown on shop drawings.

D. Acclimate wood ceiling materials by removing from packaging in installation area a minimum of 48 hours prior to installation.

3.03 INSTALLATION

A. General: Install suspended wood ceiling system in accordance with CISCA (WC).

B. Suspension System:

1. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
2. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
3. 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.
4. 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.
5. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
6. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

7. Do not eccentrically load system or induce rotation of runners.
8. Form expansion joints as detailed. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.

C. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.

D. Wood Ceiling:

1. Install wood ceilings in accordance with manufacturer's instructions.
2. Fit wood components in place, free from damaged edges or other defects detrimental to appearance and function.
3. Install components in uniform plane, and free from twist, warp, and dents.
4. Cut to fit irregular grid and perimeter edge trim.
5. Make field cut edges of same profile as factory edges, seal and finish according to manufacturer.
6. Install clips, stabilizer bars, and other attachments as indicated to secure wood ceiling components tight to the grid system.
7. Install acoustical backer above wood ceiling components; fit tight between grid members.

E. Wood Wall Panels:

1. Install according to manufacturer’s written instructions.

3.04 CLEANING

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

B. Clean and touch up minor finish damage. Remove and replace components that cannot be successfully cleaned and repaired.

END OF SECTION 095426

SECTION 096500 - RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Resilient tile flooring.

B. Resilient base.

C. Installation accessories.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 033000 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors to receive adhesive-applied resilient flooring.

C. Section 090561 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.

D. Section 260539 - Underfloor Raceways for Electrical Systems: Electrical floor cover plates for installation of resilient flooring specified in this section.

E. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers.

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. Shop Drawings: Indicate floor patterns.

D. Verification Samples: Submit two samples, 36 by 36 inch in size illustrating color and pattern for each resilient flooring product specified.

E. Verification Samples: Submit two samples, showing color and profile of each rubber base indicated on drawings.

F. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

G. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.

H. Manufacturer's Qualification Statement.

I. Installer's Qualification Statement.

J. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

K. 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: 5 percent of each type and color.
3. Extra Wall Base: 120 linear feet of each type and color.

L. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC liquid flooring finishes, sealants and adhesives.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.

B. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

C. Testing Agency Qualifications: Independent firm specializing in performing concrete slab moisture testing and inspections of the type specified in this section.

1.06 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.

C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.

D. Protect roll materials from damage by storing on end.

E. Do not double stack pallets.

1.07 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 to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 TILE FLOORING

A. Vinyl Tile - Type RS1: Solid vinyl with color and pattern throughout thickness.

1. Manufacturers: Basis-of-Design as indicated on drawings

a. Substitutions: See Section 016000 - Product Requirements.

2. Minimum Requirements: Comply with ASTM F1700, of Class corresponding to type specified.
3. Total Thickness: 0.125 inch.
4. Color: As indicated on drawings.

2.02 RESILIENT BASE

A. Resilient Base - Type RB1: ASTM F1861, Type TP, rubber, thermoplastic; style as scheduled.

1. Manufacturers: Basis-of-Design as indicated on drawings

a. Substitutions: See Section 016000 - Product Requirements.

2. Height: 4 inches.
3. Thickness: 0.250 inch.
4. Finish: Satin.
5. Color: As indicated on drawings.

2.03 ACCESSORIES

A. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.

1. VOC Content Limits: As specified in Section 016116.

B. Adhesive for Vinyl Flooring: As recommended by flooring manufacturer

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. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).

1. Test in accordance with Section 090561.
2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

D. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.

C. Prohibit traffic until filler is fully cured.

D. Clean substrate.

E. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION - GENERAL

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

C. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

D. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.

E. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

F. Install flooring in recessed floor access covers, maintaining floor pattern.

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 - RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.

B. Miter internal corners. At external corners, 'V' cut back of base strip to 2/3 of its thickness and fold. At exposed ends, use premolded units.

C. Install base on solid backing. Bond tightly to wall and floor surfaces.

D. Scribe and fit to door frames and other interruptions.

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 096723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes one resinous flooring system, one with urethane body.

1. Application Method: Notched Squeegee.

B. Related Requirements:

1. Section 018113 .14 – Sustainable Design Requirements – HPBS.

2. Section 033000 "Cast-In-Place Concrete".

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to resinous flooring including, but not limited to, the following:

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

1.5 Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.

3. Sustainable design requirements for Low VOC liquid floor finishes, sealants, and adhesives.

B. Samples for Verification: For each resinous flooring system required, 5 inches square, applied to a rigid backing by Installer for this Project.

C. Product Schedule: Use resinous flooring designations indicated in Part 2 and room designations indicated on Drawings in product schedule.

D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

E. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. No request for substitution shall be considered that would change the generic type of floor system specified (Urethane liquid applied mortar with topcoats). Equivalent materials of other manufactures may be substituted only on approval of Architect or Engineer. Request for substitution will only be considered only if submitted 10 days prior to bid date. Request will be subject to specification requirements described in this section.

B. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
2. Contractor shall have completed at least 10 projects of similar size and complexity.

C. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer, with not less than ten years of successful experience in manufacturing and installing principal materials described in this section. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

D. Manufacturer Field Technical Service Representatives: Resinous flooring manufacture shall retain the services of Field Technical Service Representatives who are trained specifically on installing the system to be used on the project.

1. Field Technical Services Representatives shall be employed by the system manufacture to assist in the quality assurance and quality control process of the installation and shall be available to perform field problem solving issues with the installer.

E. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply full-thickness mockups on 48-inch-square floor area selected by Architect.

    a. Include 48-inch length of integral cove base.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Pre-installation Conference:

1. General contractor shall arrange a meeting not less than thirty days prior to starting work.

2. Attendance:

    a. General Contractor
    b. Architect/Owner's Representative.

G. Manufacturer/Installer's Representative.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects. Store material per product data sheet.

C. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

1. Maintain material and substrate temperature between 65 and 85 deg F (18 and 30 deg C) during resinous flooring application and for not less than 24 hours after application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

D. Concrete substrate shall be properly cured. A vapor barrier must be present for concrete subfloors on or below grade. Otherwise, an osmotic pressure resistant grout must be installed prior to the resinous flooring.

1.9 WARRANTY

A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of (1) full years from date of installation, or provide a joint and several warranty signed on a single document by material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of (1) full year from date of installation. A sample warranty letter must be included with bid package or bid may be disqualified.

PART 2 - PRODUCTS

2.1 RESINOUS FLOORING

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include,

1. Basis-Of-Design Products: Subject to compliance with requirements, provide Stonhard, Inc.; Stongard® MR or a comparable approved substitution product by one of the following:

a. MiraCoat
b. Sika Corporation
c. Approved Substitutions

B. System Characteristics:

1. Color and Pattern: Select from Manufactures Standards
2. Wearing Surface: Texture TBD.
3. Integral Cove Base: Alternate 4 inches, or cover curb height.
4. Overall System Thickness: 40 mils

C. System Components: Manufacturer's standard components that are compatible with each other and as follows:

1. Primer Coat:

a. Material Basis: Stonhard Standard Primer.
b. Resin: (2) two component epoxy.
c. Formulation Description: 100 percent solids.
d. Application Method: squeegee back roll.
e. Number of Coats: One.

2. Primer Coat 2:

a. Material Basis: Stonhard SL Primer.

b. Resin: (3) three component epoxy, with 90 grit silica.
c. Formulation Description: 100 percent solids.
d. Application Method: squeegee back roll onto wet standard primer.
e. Number of Coats: One.

3. Body Coat(s):

a. Material Basis: Stonproof ME7
b. Resin: Urethane Membrane.
c. Formulation Description: 100% solids elastomeric.
d. Application Method: Notched trowel screed.
e. Number of Coats: One.

4. Topcoat: Stonkote GS4, general service sealing.

a. Material Basis: Stonkote GS4
b. Resin: Epoxy.
c. Formulation Description: 100% solids, epoxy.
d. Type: pigmented.
e. Finish: standard.

5. Number of Coats: one.

D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Elongation: 200% per ASTM D 412.
2. Tensile Strength: 1,200 psi per ASTM D 412.
3. Hardness: 70, Shore D per ASTM D 2240.
4. Abrasion Resistance: 0.06 gm per ASTM D-4060, CS-17
5. Water Absorption : 0.1% per ASTM C-413

2.2 ACCESSORY MATERIALS

A. Patching, Leveling and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

B. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated. Allowances should be included for Stonflex MP7 joint fill material.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean and dry substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Mechanically prepare substrates as follows:

a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup, or Diamond Grind with a dust free system.

2. Meet the following requirements.

a. Keep in situ probe test, ASTM F 2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 80 percent.
b. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab in 24 hours.
c. Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

D. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations. Allowances should be included for Stonflex MP7 joint fill material, and CT5 concrete crack treatment.

3.2 TERMINATIONS

A. Chase edges to “lock” the coating system into the concrete substrate along lines of termination.

B. Penetration Treatment: Lap and seal coating onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.

C. Trenches: Continue coating system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.

D. Treat floor drains by chasing the coating to lock in place at point of termination.

3.3 JOINTS AND CRACKS

A. Treat control joints to bridge potential cracks and to maintain monolithic protection.

B. Treat cold joints and construction joints and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.

C. Vertical and horizontal contraction and expansion joints are treated by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.4 FIELD QUALITY CONTROL

A. Material Sampling: Owner may at any time and any numbers of times during resinous flooring application require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.5 CLEANING, PROTECTING, AND CURING

A. Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 24 hours.

B. Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and method of application. General Contractor is responsible for protection and cleaning of surfaces after final coats.

C. Cleaning: Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer. General contractor is responsible for cleaning prior to inspection.

END OF SECTION 096723

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SECTION 096813 - TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Carpet tile, fully adhered.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 090561 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.

C. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers.

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; sizes, patterns, colors available, and method of installation.

C. Shop Drawings: Indicate layout of joints and location of edge moldings.

D. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.

E. Accessory Samples: Submit two 4 inch long samples of edge strip.

F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

G. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

H. Manufacturer's Qualification Statement.

I. Installer's Qualification Statement.

J. Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

L. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.

B. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.06 FIELD CONDITIONS

A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Tile Carpeting: Tufted, manufactured in one color dye lot.

1. Product: Basis-of-Design as indicated on drawings .
2. Color: Basis-of-Design as indicated on drawings.
3. Pattern: Basis-of-Design as indicated on drawings.

2.02 ACCESSORIES

A. Edge Strips: Embossed aluminum, color as selected by Architect.

B. Adhesives:

1. Compatible with materials being adhered; maximum VOC content as specified in Section 016116.

C. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.

C. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.

D. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).

1. Test in accordance with Section 090561.
2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.

E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.

C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.

D. Vacuum clean substrate.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install carpet tile in accordance with manufacturer's instructions.

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.

F. Locate change of color or pattern between rooms under door centerline.

G. Fully adhere carpet tile to substrate.

H. Trim carpet tile neatly at walls and around interruptions.

I. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

B. Remove excess adhesive without damage, from floor, base, and wall surfaces.

C. Clean and vacuum carpet surfaces.

END OF SECTION 096813

SECTION 097200 - WALL COVERINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall covering.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Product Data: Provide data on wall covering and adhesive.

C. Shop Drawings: Indicate wall elevations with seaming layout.

D. Samples: Submit two samples of wall covering, 8 by 8 inch in size illustrating color, finish, and texture.

E. Manufacturer's Installation Instructions: Indicate special procedures.

F. Maintenance Data: Submit data on cleaning, touch-up, and repair of covered surfaces.

G. Manufacturer's Qualification Statement.

H. Installer's Qualification Statement.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Wall Covering Materials: 25 linear feet of each color and pattern of wall covering; store where directed.
3. Package and label each roll by manufacturer, color and pattern, and destination room number.

J. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.

3. Sustainable design requirements for Low VOC coatings, materials and adhesives.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

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

1.05 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional requirements.

B. Provide panel, 3 panel drops wide, full height, illustrating installed wall covering and joint seaming technique.

C. Locate where directed.

D. Mock-up may remain as part of the Work if approved.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Inspect roll materials at arrival on site, to verify acceptability.

B. Protect packaged adhesive from temperature cycling and cold temperatures.

C. Do not store roll goods on end.

1.07 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or wall covering product manufacturer.

B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.

C. Provide lighting level of 80 ft candles measured mid-height at substrate surfaces.

PART 2 PRODUCTS

2.01 WALL COVERINGS

A. Wall Covering: Basis-of-Design as indicated on drawings.

B. Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.

C. Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.

D. Substrate Primer and Sealer: Alkyd enamel type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are prime painted and ready to receive work, and comply with requirements of wall covering manufacturer.

B. Measure moisture content of surfaces using an electronic moisture meter. Do not apply wall coverings if moisture content of substrate exceeds level recommended by wall covering manufacturer.

C. Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet nor vary at a rate greater than 1/16 inch/ft.

3.02 PREPARATION

A. Fill cracks in substrate and smooth irregularities with filler; sand smooth.

B. Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.

C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

D. Surfaces: Correct defects and clean surfaces that affect work of this section. Remove existing coatings that exhibit loose surface defects.

E. Apply one coat of primer sealer to substrate surfaces. Allow to dry. Lightly sand smooth.

F. Vacuum clean surfaces free of loose particles.

3.03 INSTALLATION

A. Apply adhesive and wall covering in accordance with manufacturer's instructions.

B. Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.

C. Butt edges tightly.

D. Overlap adjacent panels as recommended by manufacturer.

E. Horizontal seams are not acceptable.

F. Do not seam within 2 inches of internal corners or within 6 inches of external corners.

G. Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.

H. Cover spaces above and below windows, above doors, in pattern sequence from roll.

I. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.04 CLEANING

A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.

B. Reinstall wall plates and accessories removed prior to work of this section.

3.05 PROTECTION

A. Do not permit construction activities at or near finished wall covering areas.

END OF SECTION 097200

SECTION 098430 - SOUND-ABSORBING WALL AND CEILING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sound-absorbing panels.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Product Data: Manufacturer's printed data sheets for products specified.

C. Shop Drawings: Fabrication and installation details, panel layout and wood grain orientation.

D. Verification Samples: Fabricated samples of each type of panel specified; 12 by 12 inch, showing construction, edge details, and fabric covering.

E. Test Reports: Certified test data from an independent test agency verifying that panels meet specified requirements for acoustical and fire performance.

F. Manufacturer's qualification statement.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Panels: Quantity equal to 5 percent of total installed, but not less than one of each type.

H. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect acoustical units from moisture during shipment, storage, and handling. Deliver in factory-wrapped bundles; do not open bundles until units are needed for installation.

B. Store units flat, in dry, well-ventilated space; do not stand on end.

C. Protect edges from damage.

1.06 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional mock-up requirements.

B. Construct mock-up of acoustical units at location as indicated by Architect.

1. Minimum mock-up dimensions; 96 by 96 inches.
2. Mock-up may remain as part of work if approved by Architect.

PART 2 PRODUCTS

2.01 FABRIC-COVERED SOUND-ABSORBING UNITS

A. Manufacturers: Basis-of-Design as indicated on drawings

1. Substitutions: See Section 016000 - Product Requirements.

B. General:

1. Prefinished, factory assembled fabric-covered panels.
2. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.

C. Fabric-Covered Acoustical Panels for Walls:

1. Panel Core: Manufacturer's standard acoustic substrate core.
2. Sound Absorption: Noise Reduction Coefficient (NRC) of .60 when tested in accordance with ASTM C423 for Type A mounting, per ASTM E795.
3. Panel Thickness: 1 1/4 inches.
4. Fabric: 100% Wool Design Felt.
5. Color: As indicated.
6. Patterns: Where fabric with directional or repeating patterns or fabric with directional weave is used, mark for installation in same direction.

7. Mounting Method: Z-Clips preinstalled.

2.02 FABRICATION

A. Fabric Wrapped, General: Fabricate panels to sizes and configurations as indicated, with fabric facing installed without sagging, wrinkles, blisters, or visible seams.

B. Tolerances: Fabricate to finished tolerance of plus or minus 1/16 inch for thickness, overall length and width, and squareness from corner to corner.

2.03 ACCESSORIES

A. Back-Mounting Accessories: Manufacturer's standard accessories for concealed support, designed to allow panel removal, and as follows:

1. Z-clip hanger and magnet system with magnets recessed into panel frame and designed to engage steel mounting plates secured to substrate with screws.

B. Trim Moldings: Manufacturer's standard wood or vinyl trim moldings for concealing panel joints; color as selected from manufacturer's standards.

C. Furring Strips: Metal hat channel.

D. Panel Adhesive: Acceptable to acoustical panel manufacturer for application as indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates for conditions detrimental to installation of acoustical units. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install acoustical units in locations as indicated, following manufacturer's installation instructions.

B. Install mounting accessories and supports in accordance with shop drawings.

C. Install acoustical units to construction tolerances of plus or minus 1/16 inch for the following:

1. Plumb and level.
2. Flatness.
3. Width of joints.

3.03 CLEANING

A. Clean sound-absorptive panels upon completion of installation from dust and other foreign materials, following manufacturer's instructions.

3.04 PROTECTION

A. Provide protection of installed acoustical panels until Date of Substantial Completion.

B. Replace panels that cannot be cleaned and repaired to satisfaction of the Architect.

END OF SECTION 098430

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.

1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
2. Prime surfaces to receive wall coverings.

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. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, and lead items.
6. Floors, unless specifically indicated.
7. Ceramic and other tiles.
8. Brick, architectural concrete, cast stone, integrally colored plaster, and stucco.
9. Glass.
10. Acoustical materials, unless specifically indicated.
11. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 055000 - Metal Fabrications: Shop-primed items.

C. Section 099600 - High-Performance Coatings.

D. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 DEFINITIONS

A. Comply with ASTM D16 for interpretation of terms used in this section.

1.04 SUBMITTALS

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

B. Product Data: Provide complete list of products to be used, with the following information for each:

1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
2. MPI product number (e.g., MPI #47).
3. Cross-reference to specified paint system products to be used in project; include description of each system.

C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.

1. Where sheen is specified, submit samples in only that sheen.

D. Certification: By manufacturer that paints and finishes comply with VOC limits specified.

E. Manufacturer's Instructions: Indicate special surface preparation procedures.

F. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Paint and Finish Materials: 1 gal of each color; from the same product run, store where directed.
3. Label each container with color in addition to the manufacturer's label.

H. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC liquid finishes, and sealants.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.

1.06 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 and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.07 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. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F above the dew point, or to damp or wet surfaces.

D. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 fc measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide paints and finishes from the same manufacturer to the greatest extent possible.

B. Paints:

1. Pittsburgh Paints: www.ppgpaints.com/#sle.
2. Rodda Paint Co: www.roddapaint.com/#sle.
3. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
4. Benjamin Moore & Co.: www.benjaminemoore.com.

C. 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. 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 paint material in quantity required to complete entire project's work from a single production run.
4. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

B. Volatile Organic Compound (VOC) Content: See Section 016116.

C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

D. Colors: As indicated on drawings.

1. Extend colors to surface edges; colors may change at any edge as directed by Architect.

2.03 PAINT SYSTEMS - INTERIOR

A. Paint PT1 Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, wood, uncoated steel, shop primed steel, galvanized steel, and acoustical ceilings.

1. Two top coats and one coat primer.

2. Top Coat(s): Interior Latex; MPI #43, 44, 52, 53, 54, or 114.

a. Products:

1) Pittsburgh Paints Speedhide Interior Zero VOC Latex, 6-70ZV Series, Flat. (MPI #53)
2) Pittsburgh Paints Speedhide Interior Zero VOC Latex, 6-411ZV Series, Eggshell. (MPI #44)
3) Pittsburgh Paints Speedhide Interior Zero VOC Latex, 6-500ZV Series, Semi-Gloss. (MPI #54)
4) Pittsburgh Paints Speedhide Interior Latex, 6-3511 Series, Satin. (MPI #52)
5) Sherwin-Williams ProMar 200 Zero VOC Interior Latex, Flat.

6) Sherwin-Williams ProMar 200 Zero VOC Interior Latex, Semi-Gloss. (MPI #43)
7) Sherwin-Williams ProMar 200 Zero VOC Interior Latex, Eg-Shel. (MPI #52)
8) Sherwin-Williams Pro Industrial Multi-Surface Acrylic, Gloss. (MPI #114)
9) Substitutions: See Section 016000 - Product Requirements

3. Top Coat Sheen: as indicated on drawings

B. Paint PT2 Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals and wood:

1. Two top coats and one coat primer.
2. Top Coat(s): Interior Light Industrial Coating, Water Based; MPI #151, 153, or 154.

a. Products:

1) Pittsburgh Paints Pitt-Glaze WB1 High Performance Pre-Catalyzed Waterborne Epoxy, 16-1510 Series, Semi-Gloss. (MPI #153)
2) Sherwin-Williams Pro Industrial Acrylic Coating, Semi-Gloss. (MPI #153)
3) Substitutions: See Section 016000 - Product Requirements

3. Top Coat Sheen: as indicated on drawings

4. Primer: As recommended by top coat manufacturer for specific substrate.

C. Paint MI-OP-3A - Ferrous Metals, Unprimed, Alkyd, 3 Coat:

1. One coat of alkyd primer.

2. Semi-gloss: Two coats of alkyd enamel.

D. Paint MI-OP-2A - Ferrous Metals, Primed, Alkyd, 2 Coat:

1. Touch-up with alkyd primer.
2. Semi-gloss: Two coats of alkyd enamel.

E. Paint MgI-OP-3A - Galvanized Metals, Alkyd, 3 Coat:

1. One coat galvanize primer.
2. Semi-gloss: Two coats of alkyd enamel.

F. Paint MaI-OP-3A - Aluminum, Unprimed, Alkyd, 3 Coat:

1. One coat etching primer.
2. Semi-gloss: Two coats of alkyd enamel; ____.

2.04 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

1. Interior Latex Primer Sealer; MPI #50.

a. Products:

1) Pittsburgh Paints Speedhide zero VOC Interior Latex Sealer, 6-4900XI. (MPI #50)

2.05 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

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. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

E. Test shop-applied primer for compatibility with subsequent cover materials.

F. 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. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

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. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

F. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.

G. Galvanized Surfaces:

1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.

H. Ferrous Metal:

1. Solvent clean according to SSPC-SP 1.
2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning in accordance with SSPC-SP 6/NACE No.3. Protect from corrosion until coated.

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.

J. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

E. Apply each coat to uniform appearance in thicknesses specified by manufacturer.

F. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.

G. Sand wood and metal surfaces lightly between coats to achieve required finish.

H. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

I. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection.

B. Owner will provide field inspection.

3.05 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 099123

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. High performance coatings.

B. Surface preparation.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 099113 - Exterior Painting.

C. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Product Data: Provide complete list of all products to be used, with the following information for each:

1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
2. MPI product number (e.g. MPI #47).
3. Cross-reference to specified coating system(s) product is to be used in; include description of each system.
4. If proposal of substitutions is allowed under submittal procedures, explanation of all substitutions proposed.

C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.

1. Submit samples on rigid backing, 8 inches square
2. Label each coat of each sample.

D. Manufacturer's Certificate: Certify that high-performance coatings comply with VOC limits specified.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

G. Maintenance Data: Include cleaning procedures and repair and patching techniques.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Coating Materials: 1 gallon of each type and color.
3. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

I. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC coatings and sealants.

1.04 QUALITY ASSURANCE

A. Maintain one copy of each referenced document that applies to application on site.

B. Applicator Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience.

1.05 MOCK-UPS

A. See Section 014000 - Quality Requirements for general requirements for mock-ups.

B. Provide mock-up , 8 feet long by 8 feet wide, illustrating coating, color, and surface sheen , for each specified coating.

C. Locate where directed.

D. Mock-up may remain as part of the work if approved by architect.

1.06 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 coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Coating Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.07 FIELD CONDITIONS

A. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the coating product manufacturer.

C. Do not install materials when temperature is below 55 degrees F or above 90 degrees F.

D. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.

E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

F. Restrict traffic from area where coating is being applied or is curing.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Warranty: Include coverage for bond to substrate.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Only materials (primers, coatings, etc.) listed in the latest edition of the MPI Approved Product List (APL) are acceptable for use on this project.

B. Provide high performance coating products 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.

C. High-Performance Coatings:

1. Pittsburgh Paints: www.ppgpaints.com/#sle.
2. Precision Coatings: www.precisioncoatingsinc.com/#sle.

3. Sherwin-Williams Company: www.protective.sherwin-williams.com/industries/#sle.
4. Substitutions: Section 016000 - Product Requirements.

2.02 HIGH-PERFORMANCE COATINGS

A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in MPI Approved Products List.

2.03 TOP COAT MATERIALS

A. Coatings - General: Provide complete multi-coat systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated; number of coats specified does not include primer or filler coat.

1. Steel Substrates:

a. Pigmented Polyurethane over Epoxy Zinc-Rich Primer and High-Build Epoxy System MPI EXT 5.1G:

1) Prime Coat: Primer, zinc rich, epoxy, MPI #20.

(a) PPG Paints: Protective and Marine Coatings; Aquapon Zinc Rich Epoxy.
(b) Sherwin-Williams Company (The): Protective & Marine; Zinc Clad IV.

2) Intermediate Coat: Epoxy, high build, low gloss, MPI #108.

(a) Benjamin Moore & Co: Corotech; Polyamide Epoxy Semi-Gloss.
(b) PPG Paints: Protective and Marine Coatings; Aquapon High Build Epoxy.
(c) Sherwin-Williams Company (The): Protective & Marine; Macropoxy 646 Fast Cure Epoxy.

3) Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

(a) Benjamin Moore & Co: Corotech; Aliphatic Acrylic Urethane Gloss.
(b) PPG Paints: Protective and Marine Coatings; Pitthane Ultra Gloss 95-812 Series.
(c) Sherwin-Williams Company (The): Protective & Marine; Acrolon 218 HS.

2. Galvanized-Metal Substrates:

a. Pigmented Polyurethane over Epoxy Primer System MPI EXT 5.3L:

1) Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.

(a) Sherwin-Williams Company (The): Protective & Marine; Dura-Plate 235 Multi-Purpose Epoxy.

2) Intermediate Coat: Polyurethane, two component, pigmented, gloss matching topcoat.

3) Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

(a) Benjamin Moore & Co: Corotech; Aliphatic Acrylic Urethane Gloss.
(b) PPG Paints: Protective and Marine Coatings; Pitthane Ultra Gloss 95-812 Series.
(c) Sherwin-Williams Company (The): Protective & Marine; Acrolon 218 HS.

3. Powder Coating Materials For Exterior Ferrous Metal: (Factory Finish)

a. Powder Coatings, Fluoropolymer, meeting performance requirements of AAMA 2605:

1) Product: PPG Industries, Inc., Duranar Powder Coating.
2) Pencil Hardness, ASTM D 3363: F, minimum.
3) Salt Spray Resistance, ASTM G 85: 2,000 hours.
4) Humidity Resistance, ASTM D 2247: 4,000 hours.

2.04 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by coating manufacturer.

1. Anti-Corrosive for Metal, Epoxy; MPI #101.

a. Products:

1) PPG Paints; Amerlock 400 Epoxy, Semi-Gloss, AK-400 Series: www.ppgpaints.com/#sle.
2) Rust-Oleum Corporation; META Prime Epoxy Primer: www.rustoleum.com/#sle.
3) Substitutions: Section 016000 - Product Requirements.

2. Zinc Rich, Epoxy; MPI #20.

a. Products:

1) PPG Paints; Amercoat Zinc Rich Epoxy, 68HS Series: www.ppgpaints.com/#sle. (MPI #20)
2) Sherwin-Williams; Zinc Clad III HS 100: www.protective.sherwin-williams.com/#sle.
3) Substitutions: Section 016000 - Product Requirements.

2.05 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of coated surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Do not begin application of coatings until substrates have been properly prepared.

C. 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.

D. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

F. Proceed with coating application only after unacceptable conditions have been corrected.

3.02 PREPARATION

A. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

B. Clean surfaces of loose foreign matter.

C. Remove substances that would bleed through finished coatings. If unremovable, seal surface with shellac.

D. Remove finish hardware, fixture covers, and accessories and store.

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. Clean surfaces with pressurized water. Use pressure range of 1,500 to 4,000 psi at 6 to 12 inches. Allow to dry.
3. Prepare surface as recommended by coating manufacturer and in accordance with SSPC-SP 13/NACE No.6.

F. Galvanized Surfaces:

1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.

G. Ferrous Metal:

1. Solvent clean according to SSPC-SP 1.
2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning in accordance with SSPC-SP 6/NACE No.3, and protect from corrosion until coated.

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: Prior to priming, patch with masonry filler to produce smooth surface.

3.04 COATING APPLICATION

A. Apply coatings in accordance with manufacturer's written instructions, to thicknesses specified and recommendations in MPI - Architectural Painting and Specification Manual.

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 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for general requirements for field inspection.

B. Dry Film Thickness Testing: Owner will engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, and specified thickness, Contractor shall pay for retesting and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations, and specified thickness.

3.06 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.

D. See Section 017419 - Construction Waste Management and Disposal for additional requirements.

3.07 PROTECTION

A. Protect finished work from damage.

END OF SECTION 099600

SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass markerboards.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Product Data: Provide manufacturer's data on glass markerboard and accessories.

C. Shop Drawings: Indicate wall elevations, dimensions, joint locations , special anchor details.

D. Samples: Color charts for selection of color and texture of glass markerboard.

E. Manufacturer's printed installation instructions.

F. Manufacturer's Qualification Statement.

G. Maintenance Data: Include data on regular cleaning, stain removal .

H. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC sealants and adhesives.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year warranty for markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

PART 2 PRODUCTS

2.01 VISUAL DISPLAY UNITS

A. Magnetic Glass Markerboards:

1. Manufacturers:

   a. Claridge Products and Equipment, Inc: www.claridgeproducts.com/#sle.
   b. GGI - General Glass International: www.generalglass.com/#sle.
   c. Ghent, a GMI Company: www.ghent.com/#sle.

2. Glass: Laminated, low iron, 1/4 inch thick, with bevel edges and radiused corners, laminated to steel backing sheet for use with magnets. Coated or treated for use as dry erase board or projection surface.
3. Steel Backing Sheet Thickness: 24 gauge, 0.0239 inch .
4. Size: As indicated on drawings.
5. Frame: No frame, with concealed fasteners.
6. Mounting: Concealed Z clips.
7. Accessories: Provide magnetic marker tray, magnetic eraser, and magnets.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

C. Verify flat wall surface for frameless adhesive-applied boards.

3.02 PREPARATION

A. 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. Install boards in accordance with manufacturer's instructions.

B. Install with top of marker tray at 30 inches above finished floor.

C. Secure units level and plumb.

3.04 CLEANING

A. Clean board surfaces in accordance with manufacturer's instructions.

B. Remove temporary protective cover at Date of Substantial Completion.

END OF SECTION 101100

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SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Dimensional letter signage.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Product Data: Manufacturer's product literature for each type of dimensional letter sign, indicating style, font, colors, locations, and overall dimensions of each sign.

C. Shop Drawings:

1. Include dimensions, locations, elevations, materials, text and graphic layout, and attachment details.
2. Show locations of electrical service connections.
3. Include diagrams for power, signal, and control wiring.

D. Samples: Submit one sample of each type of dimensional letter sign of size similar to that required for project, indicating sign style, font, and method of attachment.

E. Selection Samples: Where materials, colors, and finishes are not specified, submit two sets of selection charts or chips.

F. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

G. Manufacturer's qualification statement.

H. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package dimensional letter signs as required to prevent damage before installation.

B. Store under cover and elevated above grade.

C. Store tape adhesive at a normal room temperature of 68 to 72 degrees F.

1.06 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. Dimensional Letter Signs:

1. CityScapes Inc: www.cityscapesinc.com/#sle.
2. FASTSIGNS International, Inc: www.fastsigns.com/#sle.
3. Inpro Corporation: www.inprocorp.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 DIMENSIONAL LETTERS

A. Applications: Building identification.

1. Use individual metal letters.
2. Mounting Location: Exterior as indicated on drawings.
3. Allow for total of 50 letters, 8 inches high.

B. Metal Letters:

1. Material: Stainless steel sheet, fabricated reverse channel.
2. Thickness: 1/8 inch minimum.
3. Letter Height: As indicated on drawings.
4. Text and Typeface:

    a. Character Font: To be selected by owner.

5. Finish: Brushed, satin.
6. Color: As selected.
7. Mounting: Concealed stud inserts.

2.04 ACCESSORIES

A. Concealed Screws: Noncorroding metal; stainless steel, galvanized steel, chrome plated, or other.

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 dimensional letter signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.

D. Protect from damage until date of substantial completion; repair or replace damaged items.

END OF SECTION 101419

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DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 101423 - PANEL SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Panel signage.

1.02 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. Sustainable Design Submittals: Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC coatings, sealants and adhesives.

D. Shop Drawings:

1. Include dimensions, locations, elevations, materials, text and graphic layout, attachment details, and schedules.
2. Schedule: Provide information sufficient to completely define each panel sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.

a. When room numbers to appear on signs differ from those on drawings, include the drawing room number on schedule.
b. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
c. Submit for approval by Owner through Architect prior to fabrication.

E. Samples: Submit two samples of each type of sign, of size similar to that required for project, indicating sign style, font, and method of attachment.

F. Selection Samples: Where colors, materials, and finishes are not specified, submit two sets of color selection charts or chips.

G. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

H. Manufacturer's qualification statement.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements for additional provisions.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

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. FASTSIGNS International, Inc: www.fastsigns.com/#sle.
2. Inpro Corporation: www.inprocorp.com/#sle.
3. Vista System LLC: 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, way finding signs.
2. Description: Photopolymer signs with applied character panel media, tactile characters as indicated on drawings.
3. Total Thickness: 1/8 inch.
4. Sign Edges: Squared.
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: Color to be selected from full line of colors.
    d. Character Color: Contrasting color.

6. Material: Acrylic plastic base with applied plastic letters and braille.
7. Tactile Letters: Raised 1/32 inch minimum.
8. Braille: Grade II, ADA-compliant.
9. One-Sided Wall Mounting: Tape adhesive.

B. Wayfinding Signage

1. Application: Interior directional and conference rooms as indicated on drawings.
2. Description: Flat signs with applied letters, 1/8 inch thick.
3. Total Thickness: 1 inch.
4. Color and font, unless otherwise indicated:

    a. Character Font: Arial
    b. Character Case: Upper and lower case
    c. Background Color: Basis-of-Design colors to be selected from 3form chroma line, allow for 4 colors to be selected.
    d. Character Color: Contrasting Color.

5. Profile: As indicated on drawings
6. One-sided Wall Mounting: Concealed mounting per manufacturers recommendations.

2.04 SIGNAGE APPLICATIONS

A. Room and Door Signs:

1. Office Doors: Identify with room names and numbers to be determined later, not those indicated on drawings; provide "window" section for replaceable occupant name.
2. Conference and Meeting Rooms: Identify with room names and numbers to be determined later, not those indicated on drawings.
3. Service Rooms: Identify with room names and numbers to be determined later, not those indicated on drawings.
4. Rest Rooms: Identify with pictograms, the names "MEN", "WOMEN" and "UNISEX", room numbers to be determined later, and braille.

B. Interior Directional and Informational Panel Signs:

1. Directories: For customer-produced media; provide divider strips.

C. Emergency Evacuation Map Panel Signs:

1. Map content to be provided by Owner.

D. Recognition/Donor Panels:

1. Dimensions and number of name signs: As indicated on drawings.

2. Provide all name signs whether engraved or not, for uniform overall appearance.

3. Provide Bronze Dedication Plaque per DFCM requirements.

E. Traffic Signs: To match campus standards; locate where indicated on drawings.

2.05 ACCESSORIES

A. 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.

Locate panel signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1. Protect from damage until substatian complettion or replace damaged items.

End of Section 101423

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SECTION 102113.17 - PHENOLIC TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Phenolic toilet compartments.

B. Urinal and vestibule screens.

1.02 RELATED REQUIREMENTS

A. Section 051200 - Structural Steel Framing: Concealed steel support members.

B. Section 102800 - Toilet, Bath, and Laundry Accessories.

C. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.04 SUBMITTALS

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

B. Product Data: Provide data on panel construction, hardware, and accessories.

C. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.

D. Samples: Submit two samples of partition panels, 12 by 12 inch in size illustrating panel finish, color, and sheen.

E. Manufacturer's Installation Instructions: Indicate special procedures.

F. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Phenolic Toilet Compartments:

1. ASI Accurate Partitions; Alpaco Elegance: www.asi-accuratepartitions.com/#sle.
2. Hadrian; Pedestal Mounted: www.hadrian-inc.com/#sle.
3. Bobrick Washroom Equipment, Inc.; Compact Grade Laminate: www.bobrick.com.
4. Substitutions: Section 016000 - Product Requirements.

2.02 PHENOLIC TOILET COMPARTMENTS

A. Toilet Compartments: Factory fabricated doors, pilasters, and divider panels made of solid phenolic core panels with integral melamine finish, floor-mounted headrail-braced.

1. Color: Single color as selected in finish schedule on drawings.

B. Doors: Gap-Free Doors & Stiles

1. Thickness: 1/2 inch.
2. Width: 30 inch.
3. Width for Handicapped Use: 36 inch, out-swinging.
4. Height: 72 inch.

C. Panels:

1. Thickness: 1/2 inch.
2. Height: 80 inch.
3. Depth: As indicated on drawings.

D. Pilasters:

1. Thickness: 3/4 inch.
2. Width: As required to fit space; minimum 3 inch.

E. Screens: Without doors; to match compartments; mounted to wall with two panel brackets with vertical support/bracing same as compartments.

2.03 ACCESSORIES

A. Pilaster Shoes: Formed ASTM A666 Type 304 stainless steel with No. 4 finish, 3 inch high, concealing floor fastenings.

1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.

B. Pilaster Pedestal Legs: Brushed stainless steel, adjustable in height plus or minus to 1 inch to support panel 4 inches above finished floor.

C. Head Rails: Hollow stainless steel, 1 inch by 1-1/2 inch size, with anti-grip profile and cast socket wall brackets.

D. Wall Brackets: Satin stainless steel; manufacturer's standard type for conditions indicated on drawings.

E. Attachments, Screws, and Bolts: Stainless steel , tamper proof type.

F. Hardware: Satin stainless steel:

1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
2. Door Latch: Slide type 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.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify correct spacing of and between plumbing fixtures.

C. 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 inch to 1/2 inch space between wall and panels and between wall and end pilasters.

C. Attach panel brackets securely to walls using anchor devices.

D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

E. Field touch-up of scratches or damaged finish will not be permitted. Replace damaged or scratched materials with new materials.

3.03 TOLERANCES

A. Maximum Variation From Plumb: 1/8 inch.

3.04 ADJUSTING

A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.

B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.

C. Adjust adjacent components for consistency of line or plane.

END OF SECTION 102113.17

SECTION 102239 - FOLDING PANEL PARTITIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Top-supported folding panel partitions, horizontal opening.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene at project site seven calendar days prior to scheduled beginning of construction activities of this section to review section requirements.

1. Require attendance by representatives of installer.
2. Notify Architect four calendar days in advance of scheduled meeting date.

1.04 SUBMITTALS

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

B. Product Data: Provide data on partition materials, operation, hardware and accessories, track switching components, and colors and finishes available.

C. Design Data: Design calculations, bearing seal and signature of structural engineer licensed to practice in the State in which the Project is located, showing loads at points of attachment to the building structure.

D. Shop Drawings: Indicate opening sizes, track layout, details of track and required supports, static and dynamic loads, location and details of pass door and frame, adjacent construction and finish trim, and stacking depth.

E. Samples for Selection: Submit two samples of full manufacturer's color range for selection of colors.

F. Certificates: Certify that partition system meets or exceeds specified acoustic requirements.

G. Manufacturer's Instructions: Indicate special procedures.

H. Designer's qualification statement.

I. Manufacturer's qualification statement.

J. Installer's qualification statement.

K. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods. Describe cleaning materials detrimental to finish surfaces and hardware finish.

L. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Perform design under direct supervision of Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified this section with minimum three years of documented experience.

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until installation.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within five year period after Date of Substantial Completion.

C. Provide two year manufacturer warranty against defects in material and workmanship, excluding abuse.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Folding Panel Partitions - Horizontal Opening:

1. Basis-of-Design: Dirtt Leaf Folding Walls.
2. Substitutions: Products meeting the requirements herein. See Section 016000 - Product Requirements.

2.02 FOLDING PANEL PARTITIONS - HORIZONTAL OPENING

A. Folding Panel Partitions: Side opening; continuous hinged panels; side stacking; manually operated.

B. Panel Construction:

1. Frame: 16 gauge, 0.0598 inch thick formed sheet steel frame top, bottom, jambs, and intermediates; welded construction, with acoustical insulation fill.
2. Panel Substrate Facing: Steel sheet, manufacturer's standard thickness.
3. Hinges: Continuous piano type, Manufacturer's standard gauge,stainless steel.

C. Panel Finishes:

1. Facing: Magnetic.

D. Panel Seals:

1. Panel to Panel Seals: Grooved and gasketed astragals, with continuous flexible ribbed vinyl seal fitted to panel edge construction; color to match panel finish.
2. Acoustic Seals: Flexible acoustic seals at jambs, meeting mullions, ceilings, retractable floor and ceiling seals, and above track to structure acoustic seal.

E. Suspension System:

1. Track: Formed steel; 1-1/4 by 1-1/4 inch size; thickness and profile designed to support loads, steel sub-channel and track connectors, and track switches.
2. Carriers: Nylon wheels on trolley carrier at top of every second panel, sized to carry imposed loads, with threaded pendant bolt for vertical adjustment.

F. Performance:

1. Acoustic Performance:

a. Sound Transmission Class (STC): 38 to 42 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90, on panel size of 100 sq ft.

2. Installed partition system track capable of supporting imposed loads, with maximum deflection of 1/360 of span.

G. Accessories:

1. Acoustic Sealant: As recommended by partition manufacturer.

2.03 MATERIALS

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify track supports are laterally braced and will permit track to be level within 1/4 inch of required position and parallel to the floor surface.

C. Verify floor flatness of 1/8 inch in 10 feet, non-cumulative.

D. Verify wall plumbness of 1/8 inch in 10 feet, non-cumulative.

3.02 INSTALLATION

A. Install partition in accordance with manufacturer's instructions and ASTM E557.

B. Fit and align partition assembly level and plumb.

C. Lubricate moving components.

D. Install acoustic sealant to achieve required acoustic performance.

E. Coordinate electrical connections.

3.03 ADJUSTING

A. Adjust partition assembly to provide smooth operation from stacked to full open position. Do not over-compress acoustic seals.

B. Visually inspect partition in full extended position for light leaks to identify a potential acoustical leak.

C. Adjust partition assembly to achieve lightproof seal.

3.04 CLEANING

A. Clean finish surfaces and partition accessories.

B. Condition markerboard surfaces in accordance with manufacturer's instructions.

3.05 CLOSEOUT ACTIVITIES

A. Demonstrate operation of partition and identify potential operational problems.

END OF SECTION 102239

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SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Corner guards.

B. Protective wall covering.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

B. Section 092216 - Non-Structural Metal Framing: Placement of supports in stud wall construction.

C. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.

C. Sustainable Design Submittals: Include:

a. Sustainable design requirements for recycled content.
b. Sustainable design requirements for regional materials.
c. Sustainable design requirements for Low VOC finishes and adhesives.

D. Shop Drawings: Include plans, elevation, sections, and attachment details.

E. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.

1. Submit two sections of corner guards, 24 inches long.
2. Submit two samples of protective wall covering, 6 by 6 inches square.

F. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.

G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Stock Materials: One package(s) of minimum 96 inches long unit of each kind of covers for corner guards.
3. Extra Stock Materials: 100 square feet of each kind of protective wall covering.

I. Maintenance Data: Manufacturer's instructions for care and cleaning of each type of product. Include information about both recommended and potentially detrimental cleaning materials and methods.

J. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC finishes and adhesive compounds.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver wall and door protection items in original, undamaged protective packaging. Label items to designate installation locations.

B. Protect work from moisture damage.

C. Do not deliver products to project site until areas for storage and installation are fully enclosed, and interior temperature and humidity are in compliance with manufacturer's recommendations for each type of item.

D. Store products in either horizontal or vertical position, in compliance with manufacturer's instructions.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 5-year manufacturer warranty for metal crash rails. Complete forms in Owner's name and register with manufacturer.

1. Failures include, but are not limited to, the following:

a. Deterioration of materials beyond that expected of normal use, as intended by manufacturer.

C. Installer Warranty: Provide 5-year warranty for metal crash rails commencing on Date of Substantial Completion. Complete forms in Owner's name and register with installer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Corner Guards:

1. Basis of Design: CS Construction Specialties, Acrovyn Corner Guards, ACO-8, 0.063" (1.6 mm) aluminum with powder coated finish to match wall color, or a comparable approved substitution by one of the following:

2. Babcock-Davis; Stainless steel: www.babcockdavis.com/#sle.
3. Construction Specialties, Inc; Heavy Duty Corner Guards: www.c-sgroup.com/#sle.
4. Inpro; SS Corner Guards: www.inprocorp.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Protective Wall Covering:

1. Construction Specialties, Inc; Acrovyn by Design Wall Covering: www.c-sgroup.com/#sle.
2. Inpro; Palladium: www.inprocorp.com/#sle.
3. MDC Interior Solutions; MDC Wall Protection - Duratec: www.mdcwall.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 PERFORMANCE CRITERIA

A. Impact Strength: Unless otherwise noted, provide protection products and assemblies that have been successfully tested for compliance with applicable provisions of ASTM D256 and/or ASTM F476.

2.03 PRODUCT TYPES

A. Corner Guards - Surface Mounted:

1. Material: Type 304 stainless steel, No. 4 finish, 16 gauge, 0.0625 inch thick.
2. Width of Wings: 2 inches.
3. Corner: Square.
4. Color: As selected from manufacturer's standard colors.
5. Length: One piece.

B. Protective Wall Covering:

1. Material: High-impact acrylic-modified vinyl.
2. Thickness: 0.040 inch.
3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
4. Color: As selected from manufacturer's standard colors.

5. Pattern: None.
6. Texture: Suede.

2.04 FABRICATION

A. Fabricate components with tight joints, corners and seams.

B. Pre-drill holes for attachment.

2.05 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.

B. Verify that substrate surfaces for adhered items are clean and smooth.

1. Test painted or wall covering surfaces for adhesion in inconspicuous area, as recommended by manufacturer. Follow adhesive manufacturer's recommendations for remedial measures at locations and/or application conditions where adhesion test's results are unsatisfactory.

C. Start of installation constitutes acceptance of project conditions.

3.02 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 above finished floor to 52 inches high.

C. Position protective wall covering no less than 1 inch above finished floor to allow for floor level variation.

1. Apply adhesive with 1/8 inch V-notch trowel to an area of wall surface that can be completed within cure time of the adhesive.
2. Install trim pieces as required for a complete installation. Allow tolerance for thermal movement.

3.03 TOLERANCES

A. Maximum Variation From Required Height: 1/4 inch.

3.04 CLEANING

A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

B. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION 102600

DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 102641 - BALLISTICS RESISTANT PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Laminated fiberglass ballistics-resistant panels.

1.02 RELATED REQUIREMENTS

A. Section 092116 - Gypsum Board Assemblies: Metal framing to receive ballistics-resistant panels.

B. Section 092216 - Non-Structural Metal Framing: Metal framing to receive ballistics-resistant panels.

C. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ABBREVIATIONS AND ACRONYMS

A. AR: Abrasion Resistant.

B. BHN: Brinell Hardness Number.

C. ITAR: International Traffic in Arms Regulations.

D. UHMWPE: Ultra High Molecular Weight Polyethylene.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

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

B. Product Data: Manufacturer's current data sheets on each product to be used.

C. Certificates: Submit printed data to indicate compliance with following requirements.

1. UL Listing verification and UL 752 Current Test Results as provided by Underwriters Laboratories.

2. Third party ballistic laboratory test report to confirm NIJ 0108.01 level of protection.

D. Manufacturer's Instructions: Indicate preparation and installation.

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

G. Warranty Documentation: Manufacturer warranty; ensure that forms have been completed in Owner's name and registered with manufacturer.

H. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

1.07 MOCK-UPS

A. See Section 014000 - Quality Requirements for additional requirements.

B. Construct 1 mock-up, 4 ft long by 4 ft wide, illustrating surface preparation techniques and application workmanship.

C. Locate where directed.

D. Mock-ups may remain as part of the work.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturer's unopened packaging bearing the brand name, manufacturer's identification, and required UL and NIJ certification labels until ready for installation.

B. Handle material with care to prevent damage. Stack panels flat, store inside under cover off the ground in a dry location, and protect from other construction activities.

1.09 FIELD CONDITIONS

A. Install products under environmental conditions (temperature, humidity, and ventilation) recommended by manufacturer.

1.10 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide ten year manufacturer warranty for materials and workmanship against defects commencing on the Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Laminated Glass Fiber Ballistics-Resistant Panels:

1. ArmorCore by Waco Composites; UL752 Level 3: www.armorcore.com/#sle.
2. Armortex; O. F. 300: www.armortex.com/#sle.
3. U.S. Bullet Proofing; USFA Fiberglass Wall Armor: www.usbulletproofing.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 LAMINATED FIBER BALLISTICS-RESISTANT PANELS

A. General:

1. Laminated fiber ballistics-resistant panels to be non-ricochet type. When struck by a bullet or projectile, the panels to delaminate in such a way that absorbs the energy, stops the projectile, and prevents ricochet or spalling.

B. Performance Requirements:

1. Ballistics Resistance Rating: Listed and labeled as tested in accordance with UL 752 Level 3 (super-power handgun) threat rating.
2. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when tested in accordance with ASTM E84.

C. Laminated Fiber Panels:

1. Material: Multiple layers of fiberglass woven roving bonded together with resin and compressed into flat rigid sheets.
2. Panel Size: 4 ft by 8 ft.
3. Panel Thickness: Nominal 1/2 inch.
4. Panel Weight: 5 psf.
5. Attachment Method: Mechanical fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation of this work.

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. Install panels in accordance with manufacturer's instructions and shop drawings and in proper relationship with adjacent construction.

1. Maintain ballistics-resistive rating at panel junctures with concrete floor and roof slabs, bullet-resistive door and window frames, and required penetrations.

B. Reinforce panel joints with a minimum 4 inch wide back-up layer of ballistics-resistant material, centered on panel joints.

C. Secure panels using screws, bolts, or industrial adhesive.

3.04 PROTECTION

A. Protect installed panels from subsequent construction operations.

B. Touch-up, repair or replace damaged panels before Date of Substantial Completion.

END OF SECTION 102641

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial toilet accessories.

B. Under-lavatory pipe supply covers.

C. Electric hand/hair dryers.

D. Diaper changing stations.

E. Utility room accessories.

1.02 RELATED REQUIREMENTS

A. Section 224000 - Plumbing Fixtures: Under-lavatory pipe and supply covers.

B. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

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.

C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

D. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC sealants and adhesives.

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. Bobrick Washroom Equipment, Inc..
4. Substitutions: Section 016000 - Product Requirements.

B. Under-Lavatory Pipe Supply Covers:

1. Plumberex Specialty Products, Inc: www.plumberex.com/#sle.

C. Electric Hand/Hair Dryers:

1. Bobrick; fino collection.
2. Substitutions: Section 016000 - Product Requirements.

D. Diaper Changing Stations:

1. American Specialties, Inc: www.americanspecialties.com/#sle.
2. Bradley Corporation: www.bradleycorp.com/#sle.
3. Koala Kare Products: www.koalabear.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. Stainless Steel Sheet: ASTM A666, Type 304.

C. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.03 FINISHES

A. Stainless Steel: Satin finish, unless otherwise noted.

2.04 COMMERCIAL TOILET ACCESSORIES

A. Toilet Paper Dispenser: Single roll, surface mounted bracket type, stainless steel, spindleless type for tension spring delivery designed to prevent theft of tissue roll.

1. Basis--Of-Design Products:

a. Bobrick Washroom Equipment, Inc.; B-4288 in all regular multi-user restroom stalls.
b. Substitutions: Section 016000 - Product Requirements.

B. Combination Toilet Paper Dispenser with Napkin Disposal: Double roll; Recessed flush with wall, stainless steel; seamless wall flanges, continuous piano hinges.

1. Waste receptacle capacity: .75 gallons.

2. Basis-Of-Design Products:

a. Bobrick Washroom Equipment, Inc.; B-3094.
b. Substitutions: Section 016000 - Product Requirements.

C. Combination Towel Dispenser/Waste Receptacle: Recessed with projecting waste receptacle, stainless steel; seamless wall flanges, continuous piano hinges, flush tumbler lock keyed like other washroom accessories.

1. Towel dispenser capacity: 600 C-fold or 800 multifold paper towels.

2. Waste receptacle capacity: 15 gallons.

3. Basis--Of-Design Products:
a. Bobrick Washroom Equipment, Inc.; B-43944.
b. Substitutions: Section 016000 - Product Requirements.

D. Automated Soap Dispenser: Foam soap dispenser, deck-mounted on vanity, with container concealed below deck; chrome-plated brass with bright polished finish; chrome-plated deck escutcheon.

1. Minimum Capacity: 30 ounces.
2. Power: Battery operated.
3. Basis-Of-Design Products:

a. Bobrick Washroom Equipment, Inc.; B-2012.

E. Mirrors: Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.

1. Size: As scheduled.
2. Frame: Radiused corners and edges ground and polished smooth.
3. LED perimeter lighting
4. Basis-Of-Design Products:

a. Bradley Corp.; Elvari LED 7B1 Series.
b. Substitutions: Section 016000 - Product Requirements.

F. Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.

1. Basis-of-Design Products:

a. Bobrick: B-3013.
b. Substitutions: Section 016000 - Product Requirements.

G. Grab Bars: Stainless steel, smooth surface.

1. Standard Duty Grab Bars:

a. Push/Pull Point Load: 250 pound-force, minimum.
b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
c. Finish: Satin.
d. Length and Configuration: As indicated on drawings.
e. Products:

1) AJW Architectural Products: www.ajw.com/#sle.
2) American Specialties, Inc: www.americanspecialties.com/#sle.
3) Bobrick Washroom Equipment, Inc..
4) Substitutions: Section 016000 - Product Requirements.

H. Purse Shelf: Fold-down, with spring-loaded hinge designed to automatically return shelf to vertical position when not in use; 0.03 inch satin-finished stainless steel, with 1/4 inch rolled or 1/2 inch channel edge at shelf front.

1. Basis-Of-Design Products:

a. Bobrick B287.
b. Substitutions: Section 016000 - Product Requirements.

I. 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. Basis-Of-Design Products:

a. Bobrick Washroom Equipment, Inc.; B-270.
b. Substitutions: Section 016000 - Product Requirements.

2.05 UNDER-LAVATORY PIPE AND SUPPLY COVERS

A. Under-Lavatory Pipe and Supply Covers:

1. Insulate exposed drainage piping, including hot, cold, and tempered water supplies under lavatories or sinks to comply with ADA Standards.

2. Exterior Surfaces: Smooth non-absorbent, non-abrasive surfaces.

3. Construction: 1/8 inch flexible PVC.

a. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
b. Comply with ICC A117.1.
c. Microbial and Fungal Resistance: Comply with ASTM G21.

4. Color: White.
5. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces.
6. Products:

a. Plumberex Specialty Products, Inc; Plumberex Handy-Shield Maxx: www.plumberex.com/#sle.
b. IPS Corporation; Truebro.
c. Buckaroos, Inc..
d. Substitutions: See Section 016000 - Product Requirements.

2.06 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. Color: As selected.
4. Minimum Rated Load: 250 pounds.
5. Products:

a. Foundations Worldwide, Inc; Classic Baby Changing Station with Stainless Frame: www.foundations.com/#sle.
b. Rubbermaid Commercial Products; FG781988 Baby Changing Station Vertical: www.rubbermaidcommercial.com/#sle.
c. Koala Kare; KB311-SSRE.
d. Substitutions: 016000 - Product Requirements.

2.07 UTILITY ROOM ACCESSORIES

A. Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, hat-shaped channel.

1. Holders: Three spring-loaded rubber cam holders.
2. Length: 36 inches.
3. Products:

a. American Specialties, Inc: www.americanspecialties.com/#sle.
b. Rubbermaid Commercial Products; FG199300 Closet Organizer/Tool Holder Kit: www.rubbermaidcommercial.com/#sle.
c. 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.

C. Verify that field measurements are as indicated on drawings.

D. See Section 061053 - Miscellaneous Rough Carpentry for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

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.

1. Grab Bars: As indicated on drawings.
2. Mirrors: 40 inch, measured from floor to bottom of mirrored surface.
3. Other Accessories: As indicated on drawings.

3.04 PROTECTION

A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 102800

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 061053 - Miscellaneous Rough Carpentry; Wood blocking product and execution requirements.

B. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 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. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

G. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

1.04 FIELD CONDITIONS

A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Extinguishers:

1. Activar Construction Products Group, Inc. - JL Industries; Cosmic Extinguisher - Multipurpose Chemical: www.activarcpg.com/#sle.
2. Ansul, a Tyco Business; Sentry: www.ansul.com/#sle.
3. Kidde, a unit of United Technologies Corp; PRO-10MP-1: www.kidde.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Fire Extinguisher Cabinets and Accessories:

1. Activar Construction Products Group, Inc. - JL Industries; Cosmopolitan Series : www.activarcpg.com/#sle.
2. Kidde, a unit of United Technologies Corp; HF7022-B: www.kidde.com/#sle.
3. Larsen's Manufacturing Co; C2409 Cameo Series: www.larsensmfg.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.

1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.

B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.

1. Class: A:B:C type.
2. Size: 10 pound.
3. Finish: Baked polyester powder coat, red color.
4. Temperature range: Minus 40 degrees F to 120 degrees F.

C. FE-36 Clean Agent Type Fire Extinguishers: Stainless steel tank, with pressure gauge.

1. Class: A:B:C type.
2. Temperature Range: Minus 40 degrees F to 120 degrees F.

2.03 FIRE EXTINGUISHER CABINETS

A. Cabinet Configuration: Recessed type.

1. Size to accommodate accessories.

B. Door: 0.036 inch 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 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. 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. Secure rigidly in place.

C. Place extinguishers in cabinets.

3.03 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide a separate maintenance contract for specified maintenance service.

3.04 SCHEDULES

A. Corridors and other locations as indicated on plans: Dry Chemical Type.

B. All Electrical and Communications Rooms: FE-36 Type.

END OF SECTION 104400

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SECTION 105129 - PHENOLIC LOCKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Phenolic lockers.

1.02 RELATED REQUIREMENTS

A. Section 061053 - Miscellaneous Rough Carpentry; Wood base construction.

B. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Shop Drawings: Indicate locker plan layout, numbering plan and combination lock code.

C. Full Size Sample: One full-size locker of each construction specified for evaluation of construction.

D. Manufacturer's Installation Instructions: Indicate component installation assembly.

E. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect locker finish and adjacent surfaces from damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Phenolic Lockers:

1. ASI Storage Solutions; Phenolic Traditional : www.asi-storage.com/#sle.
2. Columbia Lockers, a division of PSiSC; Phenolic Lockers: www.psisc.com/#sle.
3. Summit Lockers, Inc: www.summitlockers.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 LOCKER APPLICATIONS

A. Wardrobe Lockers: Phenolic lockers, recessed mounted.

1. Accessibility: Comply with ICC A117.1 and ADA Standards.
2. Width: 12 inches.
3. Depth: 15 inches.
4. Height: 72 inches.
5. Locker Configuration: Z-tier (2 lockers each with a short and long compartment).
6. Fittings: Size and configuration as indicated on drawings.

    a. Hooks: One single prong.

7. Locking: Built-in digital keypad locks.

2.03 PHENOLIC LOCKERS

A. Lockers: Factory assembled, made of phenolic core panels with mortise and tenon joints and stainless steel mechanical joint fasteners; fully finished inside and out; each locker capable of standing alone.

1. Doors: Full overlay, covering full width and height of locker body; square edges.
2. Panel Core Exposed at Edges: Machine polished, without chips or tool marks; square edge unless otherwise indicated.
3. Where locker ends or sides are exposed, finish the same as fronts or provide extra panels to match fronts.
4. Provide filler strips where indicated, securely attached to lockers.
5. Door Color: As selected by Architect; allow for 2 different colors.
6. Body Color: Manufacturer's standard white or light color.
7. Fasteners for Accessories and Locking Mechanisms: Tamperproof type.

B. Component Thicknesses:

1. Doors: 1/2 inch minimum thickness.
2. Locker Body: One of the following combinations:

    a. Tops, bottoms, and shelves 1/2 inch; sides 3/8 inch; backs 1/4 inch; minimum.

3. End Panels and Filler Panels: 1/2 inch minimum thickness.
4. Toe Kick Plates: Manufacturer's standard 1/2 inch minimum thickness.

C. Phenolic Core Panels: Nonporous phenolic resin and paper core formed under high pressure, with natural colored finished edges, integral melamine surface, matte finish, and uniform surface appearance; glued laminated panels not acceptable.

1. Surface Burning Characteristics: Flame spread index of 75 or less, and smoke developed index of 450 or less; when tested in accordance with ASTM E84.

D. Hinges: Stainless steel, black powder coat or satin finish; minimum of 180 degree opening; either exposed barrel 5-knuckle hinge attached to back of door and inside of body with tamperproof screws, or concealed cabinetwork style hinge attached with tamperproof screws.

E. Coat Hooks: Stainless steel or reinforced nylon; attached with tamperproof screws.

F. Number Plates: Manufacturer's standard, minimum 4-digit, permanently attached with adhesive; may be field installed.

G. Locks: Locker manufacturer's standard type indicated above.

H. Locker Legs: Manufacturer's standard adjustable support and leveling leg, minimum 1 inch adjustment; with hardware for attaching toe kick plates.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared bases are in correct position and configuration.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Place and secure on prepared base.

C. Install lockers plumb and square.

D. Secure lockers with anchor devices to suit substrate materials. Minimum Pullout Force: 100 pounds.

E. Bolt adjoining locker units together to provide rigid installation.

F. Install end panels and filler panels.

G. Install accessories.

H. Replace components that do not operate smoothly.

3.03 CLEANING

A. Clean locker interiors and exterior surfaces.

END OF SECTION 105129

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SECTION 107500 - FLAGPOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum Flagpoles.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete base and foundation construction.

B. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

C. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 SUBMITTALS

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

B. Product Data: Provide data on pole, accessories, and configurations.

C. Shop Drawings: Indicate detailed dimensions, base details, anchor requirements, and imposed loads.

D. Samples: Submit two physical, 4 by 4 inch in size, illustrating pole material, color, and finish.

E. Designer's Qualification Statement.

F. Maintenance Data: Provide lubrication and periodic maintenance requirement schedules and operation manuals.

G. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants, coatings and adhesives.

1.04 QUALITY ASSURANCE

A. Designer Qualifications: Design flagpole foundation under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed the State in which the Project is located.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Spiral wrap flagpole with protective covering and pack in protective shipping tubes or containers.

B. Protect flagpole and accessories from damage or moisture.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flagpoles:

1. Concord American Flagpole; Internal - Continental : www.concordamericanflagpole.com/#sle.
2. Morgan-Francis Flagpoles & Accessories: www.morgan-francis.com/#sle.
3. Pole-Tech Co, Inc: www.poletech.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

2.02 FLAGPOLES

A. Flagpoles: Designed in accordance with NAAMM FP 1001

1. Material: Aluminum.
2. Design: Cone tapered.
3. Mounting: Ground mounted type.
4. Nominal Height: 25 ft; measured from nominal ground elevation.
5. Halyard: Internal type, electric operation.

B. Performance Requirements:

1. Wind Pressure Loading on Flagpole with Flag: Resistant without permanent deformation to 140 miles/hr wind speed, in accordance with NAAMM FP 1001; the factor of safety used is 2.5.

2.03 POLE MATERIALS

A. Aluminum: ASTM B241/B241M , 6063 alloy , T6 temper.

2.04 ACCESSORIES

A. Lighting Unit: Aluminum; consisting of LED lights arranged in circular unit around flagpole.

1. Mounting Height: 12.5 ft.
2. Size: As recommended by manufacturer for flagpole diameter.
3. Aluminum Finish: Clear anodized.
4. Light Color Temperature: 3000K.
5. Products:

a. Concord American Flagpole; PoleLED
Basic: www.concordamericanflagpole.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

B. Finial Ball: Aluminum, 6 inch diameter.

C. Truck Assembly: Cast aluminum; revolving, stainless steel ball bearings, non-fouling.

D. Halyard: 5/16 inch diameter nylon, braided, white.

2.05 MOUNTING COMPONENTS

A. Foundation Tube Sleeve: AASHTO M 36, corrugated 16 gauge, 0.0598 inch steel, galvanized, depth of 42 inches as indicated.

B. Pole Base Attachment: Flush; steel base with base cover.

2.06 FINISHING

A. Metal Surfaces in Contact With Concrete: Asphaltic paint.

B. Concealed Steel Surfaces: Galvanized to ASTM A123/A123M requirements.

C. Aluminum: Anodized to aluminum , clear color.

D. Finial: Spun finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that concrete foundation is ready to receive work and dimensions are as indicated on shop drawings.

B. Verify that electric power is available and of the correct characteristics.

3.02 PREPARATION

A. Coat metal sleeve surfaces below grade and surfaces in contact with dissimilar materials with asphaltic paint.

3.03 INSTALLATION

A. Install flagpole , base assembly, and fittings in accordance with manufacturer's instructions.

B. Electrically ground flagpole installation.

C. Fill foundation tube sleeve with concrete specified in Section 033000.

D. Install foundation plate and centering wedges for flagpoles base set in concrete base and fasten.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1 inch.

3.05 ADJUSTING

A. Adjust operating devices so that halyard and flag function smoothly.

END OF SECTION 107500

SECTION 122400 - WINDOW SHADES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior manual roller shades.

1.02 RELATED REQUIREMENTS

A. Section 061053 - Miscellaneous Rough Carpentry: Concealed wood blocking for attachment of headrail brackets.

B. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week prior to commencing work related to products of this section; require attendance of affected installers.

B. Sequencing:

1. Do not fabricate shades until field dimensions for each opening have been taken with field conditions in place.
2. Do not install shades until final surface finishes and painting are complete.

1.04 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.

C. Shop Drawings: Include shade schedule indicating size, location and keys to details, head, jamb and sill details, mounting dimension requirements for each product and condition, and operation direction.

D. Certificates: Manufacturer's documentation that line voltage components are UL listed or UL recognized.

E. Selection Samples: Include fabric samples in full range of available colors and patterns.

F. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of shop drawings.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

I. Maintenance contracts.

J. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.
3. Sustainable design requirements for Low VOC materials, sealants and adhesives.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.

B. Handle and store shades in accordance with manufacturer's recommendations.

1.07 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide manufacturer's warranty from Date of Substantial Completion, covering the following:

1. Shade Hardware: One year.
2. Fabric: One year.

3. Aluminum and Steel Coatings: One year.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Interior Manually Operated Roller Shades:

1. Hunter Douglas Architectural; RB500 Manual Roller Shades: www.hunterdouglasarchitectural.com/#sle.
2. MechoShade Systems LLC; Mecho/5 System: www.mechoshade.com/#sle.
3. Rollease Acmeda Contract; Contract Series Easy Spring Air: www.rolleaseacmedacontract.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 ROLLER SHADES

A. General:

1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
2. Provide shade system that operates smoothly when shades are raised or lowered.

B. Roller Shades:

1. Description - Interior Roller Shades: Single roller, manually operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and accessories.

a. Drop Position: Regular roll.
b. Roll Direction: Roll down, closed position is at window sill.
c. Mounting: Window jamb mounted - inside, between jambs.
d. Size: As indicated on drawings.
e. Fabric: As indicated under Shade Fabric article.

2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.

a. Material: Stamped steel.

3. Roller Tubes: As required for type of shade operation.

a. Material: Extruded aluminum, baked enamel; color from manufacturer's standards.

b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge.

4. Hembars: Designed to maintain bottom of shade straight and flat.

a. Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.

5. Manual Operation for Interior Shades:

a. Clutch Operator: Manufacturer's standard material and design, permanently lubricated.
b. Drive Chain: Continuous loop, beaded ball chain with restraining device, 95 lb minimum breaking strength; comply with WCMA A100.1. Provide upper and lower limit stops.

6. Accessories:

a. Fascia: Extruded aluminum, size as required to conceal shade mounting, attachable to brackets without exposed fasteners; selected from manufacturers full range.

1) Profile: Square.

C. Roller Shades - Basis of Design: MechoShade Systems LLC; Mecho/5 System; www.mechoshade.com/#sle.

1. Description: Single roller, manually operated fabric window shades.

a. Drop Position: Regular roll.
b. Mounting: Window jamb mounted.
c. Size: As indicated on drawings.
d. Fabric: As indicated under Shade Fabric article.

2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
3. Roller Tubes:

a. Material: Extruded aluminum.
b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
d. Capable of being removed and reinstalled without affecting roller shade limit adjustments.

4. Hembars: Designed to maintain bottom of shade straight and flat.

a. Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.

5. Clutch Operator: Manufacturer's standard material and design integrated with bracket/brake assembly.

   a. Provide a permanently lubricated brake assembly mounted on an oil-impregnated hub with wrapped spring clutch.
   b. Brake must withstand minimum pull force of 50 lb in the stopped position.
   c. Mount clutch/brake assembly on the support brackets, fully independent of the roller tube components.

6. Drive Chain: Continuous loop stainless steel beaded ball chain, 95 lb minimum breaking strength. Provide upper and lower limit stops.

   a. Chain Retainer: Chain tensioning device complying with WCMA A100.1.

7. Managed Lift: Maximum required lifting force of 4 lb for single band and multi-band shades up to 30 lb hanging weight.
8. Accessories:

   a. Fascia: Extruded aluminum, size as required to conceal shade mounting, attachable to brackets without exposed fasteners; finish selected from manufactures full range.

      1) Profile: Square.

   b. Fasteners: Noncorrosive, and as recommended by shade manufacturer.

2.03 SHADE FABRIC

A. Fabric for Light-Filtering Shades: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.

1. Material: Vinyl coated polyester.
2. Performance Requirements:

   a. Flammability: Pass NFPA 701 large and small tests.
   b. Fungal Resistance: No growth when tested according to ASTM G21.

3. Openness Factor: 5%.
4. Roll Width: 72 inches.
5. Color: As selected by Architect from manufacturer’s full range of colors.
6. Fabrication:

   a. Fabric Orientation: Railroaded, fabric is turned 90 degrees off the roll.
   b. If height of opening requires multiple panels of railroaded fabric, use battens at seams.
   c. Battens: Full width of shade, enclose in welded shade fabric pocket.

2.04 ROLLER SHADE FABRICATION

A. Field measure finished openings prior to ordering or fabrication.

B. Dimensional Tolerances: Fabricate shades to fit openings within specified tolerances.

1. Vertical Dimensions: Fill openings from head to sill with 1/2 inch space between bottom bar and window sill.
2. Horizontal Dimensions - Inside Mounting: Fill openings from jamb to jamb.

C. At openings requiring continuous multiple shade units with separate rollers, locate roller joints at window mullion centers; butt rollers end-to-end.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine finished openings for deficiencies that may preclude satisfactory installation.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Start of installation shall be considered acceptance of substrates.

3.02 PREPARATION

A. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.

B. Coordinate with window installation and placement of concealed blocking to support shades.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.

B. Replace shades that exceed specified dimensional tolerances at no extra cost to Owner.

C. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.04 CLEANING

A. Clean soiled shades and exposed components as recommended by manufacturer.

B. Replace shades that cannot be cleaned to "like new" condition.

3.05 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

3.06 PROTECTION

A. Protect installed products from subsequent construction operations.

B. Touch-up, repair, or replace damaged products before Substantial Completion.

3.07 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

END OF SECTION 122400

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SECTION 123600 - COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Countertops for architectural cabinet work.

1.02 RELATED REQUIREMENTS

A. Section 018113.14 – Sustainable Design Requirements – HPBS.

1.03 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. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.

D. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.

E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

F. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

G. Installer's qualification statement.

H. Installation Instructions: Manufacturer's installation instructions and recommendations.

I. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

J. Sustainable Design Submittals: Include:

1. Sustainable design requirements for recycled content.
2. Sustainable design requirements for regional materials.

3. Sustainable design requirements for Low VOC materials, coatings, sealants and sealants.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

B. 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.

1.05 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.

1.06 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. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.

1. Flat Sheet Thickness: 1/2 inch, minimum.

2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.

    a. Manufacturers:

        1) Dupont: www.corian.com/#sle.
        2) Formica Corporation: www.formica.com/#sle.
        3) Wilsonart: www.wilsonart.com/#sle.
        4) Substitutions: See Section 016000 - Product Requirements.

    b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
    c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
    d. Color and Pattern: As indicated on drawings.

3. Other Components Thickness: 1/2 inch, minimum.

4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; edge profile as indicated on drawings; use marine edge at sinks.

5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.

6. Skirts: As indicated on drawings.

7. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.

2.02 MATERIALS

A. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.

B. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

C. Joint Sealant: Mildew-resistant silicone sealant, clear.

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.
4. Products:

a. Centerline Brackets; Front Mounting Countertop Support: www.countertopbracket.com/#sle.
b. Rangine Corporation; Rakks EH-1818FM.
c. A&M Hardware, Inc.; C(2.0)18.
d. Substitutions: See Section 016000 - Product Requirements.

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 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, unless otherwise indicated.

C. Solid Surfacing: Fabricate tops and wall panels up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

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. Install vanities in accordance with manufacturer's instructions and approved shop drawings

B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.

C. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES

A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.

B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.

C. Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING

A. Clean countertops surfaces thoroughly.

3.06 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 123600

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SECTION 12 9300 – SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following site furnishings:
   1. Bike Rack
   2. Trash Receptacle

1.3 SAMPLES & SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, field-assembly requirements and installation details.

B. Sustainable Design Submittals for recycled content and regional materials.

C. The Contractor shall provide copies of product specification sheets on all proposed site furnishings to be installed to the Owner's Representative for approval prior to the start of work, in accordance with the parameters of Division-

   1. Work may not commence until product sheets are submitted and approved. Submittals shall be marked up to show proper model, finish, etc. Products to be included:

      1. Bike Rack
      2. Trash Receptacle

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain all site furnishings through one source from a single manufacturer for each item.

B. Product Delivery, Storage and Handling:
   1. Furnish materials in manufacturer's unopened, original containers, bearing original labels showing quantity, description and name of manufacturer.
   2. Deliver and unload at the site on pallets and bound in such a manner that no damage occurs to product.
   3. Store products in a manner which will preclude damage. Damaged materials will be rejected. Remove all damaged material from the job site immediately, and replace at no cost to the Owner.

4. Furnish suitable equipment to locate all site furnishing materials carefully and efficiently. Lift materials using lifting inserts provided by manufacturer where applicable.

PART 2 -

2.1 PHYSICAL REQUIREMENTS

A. Visual Inspection:
1. The stone products shall be free of chips that extend more than (1/4") in from the edge. The cumulative length of chips on a single edge shall not exceed 5% of the length of that edge.
2. All stone products shall be free from defects that would interfere with the proper placing the stones or impair the strength or performance thereof.

A. Bike Rack

1. Basis of Design: MMCITE, STE410 – Edge Type, 41" (1,035 mm) x 2'-3" (50 mm), powder coated finish, or comparable approved substitution.

B. Trash Receptacle

1. Basis of Design: Landscapeforms, Rockford Liter + Recycling, Architectural Series – Powdercoated Metal, Fine Texture, color selected by architect, or a comparable approved substitution.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not install site furnishings prior to acceptance by Owner of area to receive such materials.

B. Examine area and conditions for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.

C. Verify drawing dimensions with actual field conditions.

D. Report to the Owner all conditions which prevent proper execution of this work or that are different from those shown. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions, unless more stringent requirements are indicated on Drawings.

B. All metal inserts, anchor slots, anchors, anchor bolts, fastenings, and other fastening devices, for attachment of site improvement items to concrete and masonry, shall be stainless steel.

C. Contractor shall be responsible for the correct location of site improvement items. Free-standing site improvement items shall be set plumb and horizontal regardless of the pitch of the finished surrounding grade unless otherwise shown on Drawings.

3.3 GUARANTEE

A. Contractor will furnish and deliver standard written manufacturer's guarantee in Owner's name covering all materials and workmanship under this section, in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.

B. Contractor shall pay for repairs of any damage to any part of the project or caused by defects in his work and for any repair to the materials or equipment caused by replacement. Complete all repairs to the satisfaction of the Owner's Representative.

C. Replace any part of the work installed under this contract requiring excessive maintenance. Work of this nature will be considered defective. Replace at no cost to the Owner upon notification during the one-year guarantee period.

3.4 CLEANING

A. Keep all areas of work clean, neat and orderly at all times.

B. Clean up and remove all debris from the work area to satisfaction of Owner prior to Final Acceptance.

END OF SECTION

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DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 211313 - FIRE SPRINKLER SYSTEM

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the contract apply to this section.

B. Technical sections which describe related work such as Division 26 apply to this section.

C. Division 23 Basic Mechanical Requirements section applies to the work of this section.

D. Separate sections of Division 23 specify Hangers and Supports, Expansion Compensation, piping system identification materials and requirements and pipe insulation.

1.2 SUMMARY:

A. Furnish all materials, equipment and supplies and perform all work and operations to construct and make functional a wet-pipe fire sprinkler system to provide fire protection of all areas of the Farmington Regional Center in Farmington, UT. The design shall meet the requirements of the IBC, IFC, NFPA 13, Utah State Fire Marshal's Office, bid drawings and specifications. Reference to other specifications, codes, standards or manuals which are a part of these specifications, but are not included herein, shall be the latest adopted edition of these publications.

1.3 QUALITY ASSURANCE:

A. Materials, devices and equipment shall be Underwriters Laboratories listed or Factory Mutual approved for use in fire protection systems.

B. Installer: The subcontractor for each of the fire protection systems shall be duly licensed by the state, country and city in which the project is being constructed. The sub-contractor must be engaged in the installation of the types of automatic fire protection systems required for this project and be fully familiar with all local conditions, specified codes and requirements.

C. Designer: The designer for the fire sprinkler system shall be a staff employee of the "Installer" and shall be a licensed fire protection engineer (Utah registration) or a Certified Engineering Technician in Fire Protection (NICET level III minimum). The Certification shall be active during the entire contract period. The designer shall certify that the drawings and installation are in accordance with the intent of the plans and specifications. The designer shall make a complete and final inspection of the installation, including operating all alarms, control valves, checking all piping, seismic bracing, hangers, etc. After checking all

components of the system, he shall provide a letter stating that the installation is complete, operational and in accordance with the approved plans and specifications. If changes have been made to the installation since the plans were approved, the designer shall correct the shop drawings and provide as-built drawings to the Owner with the letter.

1.4 SUBMITTALS:

A. Shop Drawings: The fire sprinkler contractor shall prepare complete shop drawings for each fire sprinkler system. Shop drawings shall be coordinated with structure and with all other trades. Show ceiling grid, lights, grilles, ducts, registers and diffusers, smoke detectors, sound speakers, etc. Draw sections to show relative elevations of piping, ductwork, conduit, cable trays, ceiling grid, beams, etc. Show heads symmetrically related to ceiling patterns and show heads centered in tiles in grid. The shop drawings shall contain, as a minimum, the information outlined and listed in NFPA 13. Submit fire sprinkler drawings, equipment data sheets and hydraulic calculations to each Authority Having Jurisdiction for review prior to starting work. Final design shall incorporate all the requirements of the AHJ's. Work only from reviewed documents.

B. Hydraulic Calculations: Furnish complete hydraulic calculations for the hydraulically most remote area of each different occupancy classification of each fire sprinkler zone.

C. Descriptive Data: Descriptive data shall be submitted on the following items of material and/or equipment. Such data shall consist of manufacturer's or supplier's catalog information in sufficient detail to allow verification that the material and/or equipment meets the specification requirements or is equal to that specified.

1. Valves
2. Backflow preventer
3. Pipe
4. Pipe supports and braces
5. Fittings and couplings
6. Fire department connection
7. Sprinklers
8. Valve tamper switches
9. Water flow alarm switches

D. Upon completion of installation submit to Architect two copies each

1. Contractor's Material & Test Certificate for Aboveground Piping.
2. As-built shop drawings with designer's signature and certification number.

1.5 WORK INCLUDED:

A. Wet-pipe fire sprinkler system per IBC, IFC and NFPA 13 and Utah State Fire Marshal's requirements to protect all areas of building. Work includes but is not limited to:

1. Design and installation drawings, including hydraulic calculations.
2. Fire sprinkler riser.
3. Remote, wall mounted Fire Department Connection (FDC)
4. Control valve assemblies to create multiple zones of fire sprinklers (maximum 52,000 sq ft per zone).
5. Pipe, fittings, sway bracing, and supports
6. Test/drain valves and discharge piping.
7. Signs, sprinklers and sprinkler escutcheons
8. Testing and documentation.

1.6 RELATED WORK:

A. Painting.
B. Excavation and Backfill.
C. Electrical Materials and Methods.
D. Fire Alarm and Detection.

1.7 SYSTEM DESCRIPTION:

A. Design, furnish and install a wet-pipe fire sprinkler system in accordance with NFPA 13 and Utah State Fire Marshal's Office, to provide fire protection of all areas of the building. Work includes but is not limited to the following:

1. Furnish and install 6" fire protection water supply to building. Fire protection water supply shall be installed, flushed and tested in accordance with all applicable provisions of NFPA 13 and NFPA 24. Install fire service entry to Fire Riser 125 and install double check assembly (backflow preventer) to isolate fire protection water from public supply. See paragraph 4.1 of this section for schematic fire sprinkler riser detail.

2. A single zone of fire sprinklers shall be provided to protect the 33.500 sq ft building.

3. Provide a 2-way, wall mounted Fire Department Connection (FDC). Install FDC on exterior wall of Fire Riser 125. Install check valve and automatic drip drain as near as possible to exterior wall to prevent freezing. Install 4" piping from FDC to fire risers. Connect FDC downstream of system backflow preventer.

4. Piping shall be concealed above ceilings where ceilings are present and may be run exposed in areas without ceilings. Where horizontal piping is exposed, the piping shall be run as high as possible to avoid conflicts with suspended lights and ductwork. All exposed piping shall be painted to match the color of the surrounding area.

5. Where practical, install piping to drain back to the riser. Where piping cannot be pitched to drain to the riser, provide auxiliary drains to facilitate drainage of the fire sprinkler piping.

6. The sprinkler systems shall be coordinated with all other trades. Where conflicts arise, it shall be the responsibility of the fire sprinkler contractor to

relocate piping or other system devices to an acceptable location.

7. Install fire sprinklers to protect throughout the entire building. Fire sprinklers may only be omitted from spaces only where specifically allowed by NFPA 13.

8. Piping shall only be installed in areas where temperatures will not drop below 40° F. If piping must be installed in areas where the temperature is not maintained above 40 °F, the piping must be part of an antifreeze loop or dry-pipe system in conformance with the requirements of NFPA 13.

1.8 SYSTEM DESIGN:

A. Design densities and areas of application shall meet the minimum requirements of NFPA 13 as outlined below:

1. Ordinary Hazard Group 1 (Storage 410, Storage 411, Storage 510, Electrical 111, Closet 112A, Telecom 110, Mechanical 122, Receiving 123, Lawn Equipment 124, Fire Riser 125 and similar areas): 0.15 gpm/sq ft over entire room or 1,500 sq ft (whichever is larger) with 250 gpm hose allowance.

2. Light Hazard (all other areas): 0.10 gpm/sq ft over 1,500 sq ft with 1000 gpm hose allowance.

B. Maximum coverage per sprinkler head.

1. Light Hazard: 225 sq. ft.
2. Ordinary Hazard: 130 sq. ft

C. The design area shall be the hydraulically most remote rectangular area having a dimension parallel to the branch line equal to, or greater than, 1.2 times the square root of the area of sprinkler operation.

D. Hydraulic calculations for the fire sprinkler system shall extend to the point of connection to the nearest circulating water supply main. The following pressures and flow may be used for planning/estimated purposes:

Static Pressure: XX psi
Residual Pressure: XX psi
Flow: X,XXX gpm

E. The Fire Protection subcontractor shall perform a fire hydrant flow test in accordance with NFPA 291 after the award of the contract but before beginning design of the fire sprinkler system. Apply appropriate reduction factors to account for seasonal variations. Schedule all flow tests with Spanish Fork personnel. Submit a copy of the flow test report to the project engineer.

F. A minimum 10% pressure cushion shall be provided in all hydraulic calculations.

1.9 WARRANTY:

A. Materials, equipment, and workmanship shall be free from defects for 12 months from the "Date Left in Service with All Control Valves Open," shown on "Contractor's Material and Test Certificate." If any Work is found to be defective, Contractor shall promptly, without cost to Owner, and in accordance with Owner's instructions, either correct such defective Work, or if it has been rejected by Owner, remove it from the site and replace it with non-defective Work. Submit two copies of Warranty Certificates to Architect.

1.10 REFERENCES:

A. NFPA (National Fire Protection Association) 13, "Installation of Sprinkler Systems" 2019
B. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances, 2019
C. IFC (International Fire Code), 2021
D. IBC (International Building Code), 2021
E. Underwriters Laboratories "Fire Protection Equipment Directory," current edition
F. Factory Mutual Systems "Approval Guide," current edition

PART 2 - PRODUCTS

2.1 Acceptable manufacturers of sprinkler equipment, heads and devices.

A. Tyco
B. Viking
C. Reliable.
D. Victaulic.

2.2 PIPE:

A. Piping shall be black steel and shall meet or exceed the following standards: ASTM A795, ANSI/ASTM A53, ASTM A135, ANSI B36-10M, UL CRR (Corrosion Resistance Rating) minimum 1.0 for threaded pipe.

2.3 FITTINGS:

A. Interior Piping:

1. Cast iron threaded, ANSI B16.4.
2. Cast iron flanged, ANSI B16.1.
3. Malleable iron threaded, ANSI B16.3.
4. Forged steel fittings, socket welded and threaded, ANSI B16.11.
5. Plain end couplings and fittings, saddle couplings, and clamp type couplings are not acceptable.
6. Fittings shall be rated for the maximum static pressures present in the fire protection system.
7. Other types of fittings may be used, but only those investigated and listed for this service and approved by the project engineer.

2.4 HANGERS:

A. Hangers shall conform to the minimum requirements of NFPA 13.

2.5 SEISMIC FITTINGS AND BRACES:

A. Earthquake bracing is required and shall conform to the minimum requirements of NFPA 13. Use seismic coefficient (Cp – NFPA 13 Table 18.5.9.3) of 0.65 in calculations for fire sprinkler seismic bracing unless a greater coefficient is required by the local authority having jurisdiction.

2.6 SPRINKLERS:

A. All areas with finished ceilings: Quick response, recessed pendent type with white finish and white escutcheon, glass bulb, 1/2" orifice, and 165° F temperature rating.

B. Areas without finished ceilings: Quick response upright or pendent, glass bulb type, brass, 1/2" orifice, ordinary temperature rated.

C. Fire sprinklers shall be installed in accordance with NFPA 13 and manufacturer's requirements. Specific coordination between the Fire Sprinkler Contractor and any other Contractors is to occur to prevent obstructions to fire sprinkler heads.

D. Provide a minimum of 12 spare heads of each type in a cabinet and one head wrench for each type of sprinkler. The minimum number and type of spare sprinklers provided shall be in accordance with NFPA 13.

2.7 VALVES:

A. Fire Sprinkler System Risers:

1. Double Check Valve Assembly, listed for horizontal installation, meeting Utah Fire / Plumbing Code requirements.
2. Butterfly pattern system control valves with built-in tamper switch.
3. 2" angle valve for main drain.

2.8 FIRE DEPARTMENT CONNECTION:

A. Wall mounted, brass, projecting type 2-way fire department connection including placard and caps. The placard shall read: "AUTO SPKR". The connection shall meet the requirements of the Farmington City Fire Department.

2.9 ALARM DEVICES: Note: Devices are furnished and installed by fire sprinkler contractor and wired by fire alarm contractor.

A. Fire Sprinkler System Riser:

1. Valve tamper switches: The valve tamper switches shall be SPDT electrical switches rated for 125 Vac for monitoring the position of control. Switches shall be built-in on the butterfly pattern control valves.

2. Water flow switch: Furnish and install a water flow detector, designed for wet pipe sprinkler systems. The detector shall be a vane type water flow switch installed on the system piping downstream of control valve. Activation of switch shall provide actuation of two SPDT switches rated for 125 Vac at water flows of 10 gpm or greater.

B. Water Flow Alarm:

1. Provide and install a weather-proof 120 VAC or 24 VDC horn/strobe (75 cd strobe) on the exterior of building. Locate the water flow alarm on the portion of the wall nearest to the FDC. Location of water flow alarm shall be approved by the project architect. Power to water flow alarm and wiring to fire alarm systems shall be the responsibility of the fire alarm contractor.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Inspect job site prior to fabricating materials. Coordinate and sequence installation with the progress of other mechanical and structural systems and components.

3.2 INSTALLATION:

A. Install systems in compliance with methods detailed in NFPA 13 and IBC, including seismic requirements.

B. Offset as needed for other trades. Avoid conflict in areas of tight construction. Do not obstruct access to air control boxes, access doors, lights or other ceiling mounted equipment.

C. Submit piping and equipment data sheets for review by the Architect/Engineer prior to start of the installation.

D. Close pipe openings with caps or plugs during installation. Cover and protect components of the system against dirt and chemical or mechanical injury.

E. Paint exposed piping for sprinkler system to match the color of the surrounding structure.

F. Provide concrete splash blocks for drains test valve discharge, etc. Concrete splash blocks shall be prefabricated, 2-1/2" thick, Amcor or Engineer approved equal.

G. Piping shall only be installed in areas where temperatures will not drop below 40 °F. If piping must be installed in areas where the temperature is not maintained above 40 °F, the piping must be part of an antifreeze or dry-pipe system in conformance with the requirements of NFPA 13.

H. Provide white painted escutcheons around exposed piping where piping passes

through walls or ceilings in a finished area.

3.3 FIELD QUALITY CONTROL:

A. Obtain permits and post bonds as required by state and local AHJ's (Authorities Having Jurisdiction).

B. Inform AHJ's of job progress. Request presence of AHJ'S, perform tests, and document results using Contractor's Material and Test Certificates.

3.4 TESTING: All tests shall be scheduled through Owner's construction coordinator and shall be witnessed by representatives of the Owner and the Spanish Fork Fire Department

A. Hydrostatically test all system piping for two hours at 200 psi (or 50 psi higher than the maximum anticipated static pressure) with no loss in pressure and no visible leakage. Conduct the testing after all of the fire sprinkler heads and piping are installed. Have the tests witnessed by the AHJ's and Engineer. Submit a Contractor's Material and Test Certificate to the Architect upon successful completion of the testing.

B. Perform all system operation tests for fire sprinkler system required by NFPA 13 and the Utah State Fire Marshal's Office. Every water flow detector used on the project must be tested to ensure proper operation and retard settings.

C. Flush, test, and inspect sprinkler systems according to NFPA 13.

D. Train the Owner's maintenance personnel in the proper operation, testing and maintenance of all installed equipment.

E. Conduct an inspection and operational test (main drain and inspector's test) at the end of the one-year guarantee period. The inspection and testing shall be in accordance with the manufacturer's recommendations and NFPA 25. A written report is to be sent to the Owner upon completion of the inspection. Fire sprinkler installer shall conduct the tests.

3.5 CLEANING:

A. Remove oil, scale, debris, and foreign substances from the interior and exterior of devices, equipment, and materials prior to installation.

B. Upon job completion, remove tools, surplus materials and equipment, leaving all areas broom clean.

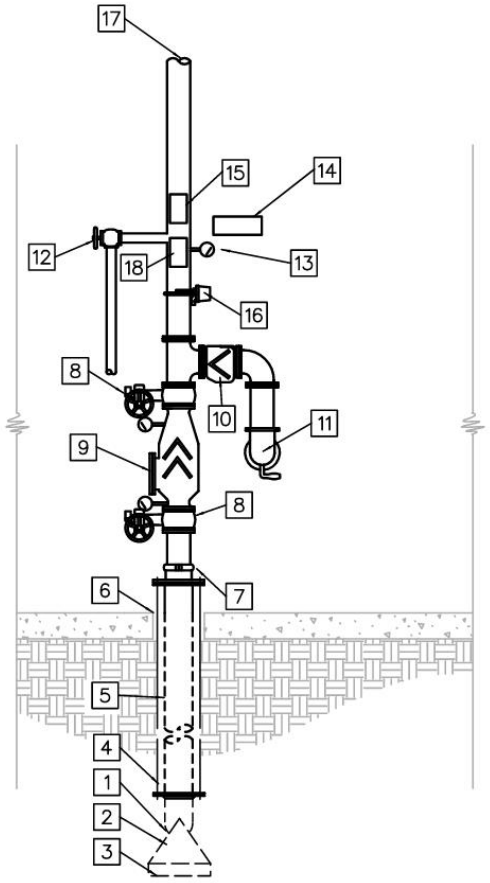
3.6 ACCEPTANCE:

A. Acceptance of installation is subject to final inspection and approval by:

1. Owner
2. State of Utah DFCM
3. Utah State Fire Marshal's Office
4. Architect or his representative.

PART 4 – DETAILS

4.1 FIRE SPRINKLER RISER SCHEMATIC



1 — 6" UNDERGROUND SUPPLY PIPING (BEYOND)
2 — 90° M.J. BEND
3 — CONCRETE THRUST BLOCK, SIZED PER NFPA #13
4 — ANCHOR RODS, PER NFPA #13 - PROVIDE CORROSION PROTECTION
5 — CEMENT LINED DUCTILE IRON FLANGE X SPIGOT PIECE - TRANSITION FROM UNDERGROUND SUPPLY TO INTERIOR PIPING
6 — SLEEVE AT FLOOR SPACE WITH 2" CLEAR SPACE AROUND PIPE - FILL SPACE WITH MASTIC
7 — FLEXIBLE COUPLING/FITTING
8 — BUTTERFLY CONTROL VALVE WITH BUILT-IN TAMPER SWITCH AND ATTACHED LOCKING CHAIN
9 — 4" AMES COLT SERIES C200BFG DOUBLE CHECK ASSEMBLY (OR EQUAL)
10 — 4" CHECK VALVE
11 — 4" TO 2-WAY, WALL MOUNT FIRE DEPARTMENT CONNECTION. PROVIDE 1/2" AUTO BALL DRIP
12 — 2" COMBINATION DRAIN AND INSPECTOR'S TEST VALVE WITH 1/2" ORIFICE. EXTEND DISCHARGE TO BUILDING EXTERIOR.
13 — PRESSURE GAUGE
14 — SPARE SPRINKLER CABINET, PER NFPA 13. PROVIDE LIST OF SPRINKLERS PER NFPA 13 6.2.9.7.1.
15 — HYDRAULIC DESIGN INFORMAITON SIGN
16 — VANE TYPE WATER FLOW SWITCH
17 — SUPPLY TO FIRE SPRINKLERS
18 — GENERAL INFORMATION SIGN PER NFPA 13 25.6.

FIRE SPRINKLER RISER SCHEMATIC

END OF SECTION

SECTION 220100 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

A. General Conditions and Division 01 apply to this Division.

1.2 SCOPE

A. Includes -

1. Furnish all labor, materials, and equipment necessary for the completion of the mechanical and plumbing scope of work.
2. Furnish and install all motors specified in this Division and be responsible for the proper operation of electrical powered equipment furnished by this Division.
3. Furnish exact location of electrical connections and information on motor controls to Division 26.
4. Mechanical Contractor shall obtain the services of independent Test and Balance Agency.
5. Placing the air conditioning, heating, ventilating, and exhaust systems into full operation and continuing their operation during each working day of testing and balancing.
6. Making changes in pulleys, belts, and dampers, or adding dampers, as required for the correct balance as recommended by Balancing Contractor at no additional cost to Owner.
7. Air balance, final adjustment and test run.
8. The satisfactory performance of the completed systems is a requirement of this specification.

B. Related Work Specified Elsewhere

1. Conduit, line voltage wiring, outlets, and disconnect switches specified in Division 26.
2. Magnetic starters and thermal protective devices (heaters) not a factory mounted integral part of packaged equipment are specified in Division 26.

1.3 SITE OBSERVATION

A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS

A. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc; however, locations are to be regarded as shown diagrammatically only. Follow as closely as actual building construction and work of other trades will permit.

B. Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate existing structural and finished conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.
If changes in location of piping, equipment, ducts, etc. are required due to lack of coordination of work under this division, such changes shall be made without charge. Contractor shall review drawings with local and state agencies having jurisdiction and any changes required by them shall be brought to the attention of the Engineer prior to bidding or commencement of work. It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for the installation of systems according to the true intent and meaning of the Contract Documents. Anything not clear or in conflict will be explained by making application to the Engineer in writing. Should conditions arise where certain changes would be advisable, secure Owner's and Engineer approval for these changes before proceeding with work.

1.5 COORDINATION OF WORK:

A. Coordinate work of various trades in installing interrelated work. Before installation of mechanical items, make proper provision to avoid interferences in a manner approved by Engineer. Changes required in work specified in Division 22 and 23 caused by neglect to secure approval shall be made at no cost to Owner.

B. Arrange piping, ductwork, and equipment to permit ready access to valves, unions, starters, motors, control components, and to clear openings of doors and access panels. Contractor shall provide all necessary access doors and/or panels to provide complete access to all mechanical equipment, dampers, or accessories. Doors for dampers, etc. shall be minimum 12" x 12" and doors for mechanical equipment shall be minimum 24" x 24".

C. Furnish and install inserts and supports required by Division 22 and 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions involved in sufficient time to be built into the construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Contractor.

D. Be responsible for required digging, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Owner and Architect. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.

1. Patch and repair walls, floors and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
2. This Division shall bear expense of cutting, patching, repairing, and replacing of work of other Divisions because of its fault, error, tardiness, or because of damage done by it.
3. Provide the necessary cutting, patching, repairing, and replacing pavements, sidewalks, etc. to permit installation of work of this Division.

E. Adjust locations of piping, ductwork, equipment, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and cut prior to fabrication.

1. Make offsets, transitions, and changes in direction of piping, ductwork, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.

F. Slots and openings through floors, walls and roofs shall be provided by this Division.

G. This Contractor shall schedule his work, store his equipment and materials, and work in harmony with other Contractors so as to not delay or jeopardize the construction.

H. This Division shall coordinate with electrical contractor to insure that all required components of control work are included and fully understood. Any discrepancies shall be called to the attention of the Engineer before completion of bids. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.6 EQUIPMENT & MATERIALS:

A. Requests for substitution shall be received in writing a minimum of seven days prior to bidding. Prior acceptance shall be by Manufacturer's name only. Items not listed in this specification or subsequent addendums shall not be considered. No oral approvals will be acceptable. Manufacturers listed in this specification are acceptable only for items listed. All other items manufacturer wishes to bid must be prior approved. All equipment shall be subject to final review in accordance with "Project Submittals".

B. Product Approvals -

1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.

2. In the event other than specified equipment is used and will not fit job site conditions, this Division assumes responsibility for replacement with items named in Specification.

C. Use domestic made pipe, pipe fittings, and motors on Project.

D. Motor and equipment name plates as well as applicable UL labels shall be in place when Project is turned over to Owner.

E. Insure that items to be furnished fit spaces available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. Do not scale off drawings.

F. All materials shall be of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended. Materials shall be new unless specifically excepted.

G. Equipment catalog or model numbers shown define the basic equipment types and quality standard only. Catalog numbers shall not be considered as all inclusive and shall be verified to include all devices, controls, operators, and appurtenances necessary for the satisfactory and complete operation of the equipment.

H. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.

1. Promptly notify Engineer in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain Engineer's written instructions before proceeding with work. Contractor shall bear all expenses arising from correcting deficiencies of work that does not comply with Manufacturer's directions or such written instructions.

I. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in a dry, heated space.

1.7 PROJECT SUBMITTALS:

A. Furnish complete catalog data for manufactured items of equipment to be used in the Work to for review within 15 days after award of Contract.

B. Submittal shall include, but not be limited to the following:

1. equipment scheduled
2. balancing contractor
3. insulation
4. grilles, and diffusers
5. automatic temperature controls
6. certificates of guarantee
7. valves
8. plumbing fixtures, accessories, and specialties
9. any item for which more than one manufacturer is mentioned

C. Submit a minimum of five copies of data in binders and index in same order and name as they appear in Specification. - Optional: Provide electronic submittals. Electronic submittals shall be in .pdf format, and shall be compiled into a single file, with bookmarks for each piece of equipment.

1. State sizes, capacities, brand names, motor HP, electrical requirements, accessories, materials, gauges, dimensions, and other pertinent information.
2. List on catalog covers page numbers of submitted items.
3. Underline or highlight applicable data.

D. If material or equipment is not as specified or submittal is not complete, it will be rejected.

E. Catalog data or shop drawings for equipment which are noted as approved shall not supersede Contract Documents.

F. Review comments shall not relieve this Division from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.

G. Check work described by catalog data with Contract Documents for deviations and errors.

H. All items other than first named specified equipment shall show and state all exceptions and deviations taken and shall include design calculations and drawing layouts.

I. The Contractor shall review the submittals prior to submission to make sure that the submittals are complete in all details. No submittal will be reviewed which does not bear the contractor's notation that such checking has been made.

J. No partial submittals will be considered unless approved by the Engineer.

K. Manufacturers' names shall be mentioned as acceptable prior to bidding.

L. Contractor shall verify equipment dimensions to fit the spaces provided with sufficient clearance for servicing the equipment.

M. Contractor shall review equipment submittals for compliance with schedules, specifications, and drawing plans and details. Equipment submittal shall show the proper arrangements to suit installation and maintenance such as motor location, access doors, filter removal, piping connections, etc.

N. Equipment submittal sheets shall be clearly marked indicating equipment symbol and exact selection of proposed equipment. Submittals shall clearly indicate name of manufacturer of each item.

O. For unacceptable items, the right shall be reserved to require the first named specified items.

P. Where submittals are sent with any of the above listed information missing or are incomplete they will be returned to the contractor unchecked to be completed and resubmitted. No additional time or money shall be allowed for failure to provide complete submittals on the first review.

Q. If an item requiring submittal review is ordered, purchased, shipped, or installed prior to the submittal review the item shall be removed from the job site and replaced with an approved item at contractors expense.

1.8 CLEANING & FINISHING:

A. Contractor shall, at all times, keep the premises free from waste material and rubbish. Upon completion of this Section of the work, Contractor shall remove all surplus materials and rubbish; clean all spots resulting from the mechanical work from hardware, floors, glass, walls, etc.; do all required patching up and repair all work of other trades damaged by Contractor under this Section of the work, and leave the premises in a clean orderly condition. Clean heating and cooling coils, internally and externally, and replace all air filters prior to final mechanical inspection. Remove rust, plaster, dirt, grease and oil before painting, insulating, or exposing to view the equipment, piping, ductwork, etc. in completed structure. Refinish any damaged surfaces and leave in proper working order at final completion.

1.9 EQUIPMENT SERVICING:

A. Prior to starting mechanical equipment, all motors, bearings and moving parts shall be properly oiled, greased and lubricated as required. Full and adequate maintenance service shall be given and upon completion all equipment shall be cleaned and checked and placed in perfect condition for the Owner.

B. Amount and type of lubricant shall be per manufacturer's specification.

1.10 SUPERVISION:

A. The Contractor shall supervise and direct the work with his best skill and attention. He will be solely responsible for the means, methods, techniques, sequences and procedures of construction. The Contractor will be responsible to see that the finished work complies accurately with the Contract Documents.

1.11 SAFETY REGULATIONS:

A. Contractor shall provide equipment, supervision, construction, procedures, and everything necessary to assure safety of life or property.

B. Refer also to General Condition and Special Conditions for protection clauses.

1.12 LEAK DAMAGE:

A. Contractor shall be responsible for damages to the work of other Contractors or to the building, or to its contents, people, etc., caused by leaks in any of the equipment or piping installed by him through equipment or material failures, leaking joints or disconnected pipes, fittings, or by overflows and shall make at his own expense all repairs to fixtures, building interior, contents, paint, rugs, furniture, ceiling tile, and equipment so damaged.

1.13 TOOLS AND STORAGE OF EQUIPMENT:

A. The Contractor shall furnish all necessary tools, staging and whatever may be necessary for the installation of this work and shall at all times protect this work and others, and the materials to be used therein from damage by the weather, accident and other causes, and shall repair and make good any damage thus occurring.

1.14 WORKMANSHIP:

A. Workmanship shall be the best quality of its kind for respective industries, trades, crafts and practices and shall be acceptable in every respect to the Owner and Engineer. Nothing contained herein shall relieve the Contractor from performing good work, perfect in all details of construction.

1.15 TEMPORARY FACILITIES:

A. Furnishing of temporary water, space heating, sanitary facilities, drainage lines, light and power will be as specified in Division 01 General Conditions. Contractor shall arrange to bring facilities to required location of premises. All expenses involved shall be paid by the Contractor as described in General and Special Conditions.

1.16 PAINTING BY CONTRACTOR:

A. Painting shall be by persons experienced in painting.

B. All exposed, insulated, and bare piping, equipment, metal stands and supports shall be painted as follows:

1. The prime coat on equipment shall be factory applied. The finish coats shall be applied under Section 09900 of these specifications.

2. All equipment which is to be furnished in finished painted condition by Contractor shall be left without mark, scratch or impairment to finish upon completion and acceptance of job. Any necessary refinishing to match original shall be done by Contractor. Do not paint over name plates, serial numbers or other identifying marks.
3. All new piping shall be painted as required in Section 22 and 23. Paint colors shall conform to color code requirements as specified "Identification of Piping and Equipment".

1.17 EQUIPMENT BASES:

A. Provide reinforced concrete bases under boilers, chillers, pumps, air handling units, and other equipment as necessary or as indicated on the drawings. Coordinate work with Division 03.

B. Bases shall be 6" high, above the finish floor. The base shall extend beyond the equipment 6" in all directions, where possible. Inserts and vibration isolation systems shall be provided and installed by the Mechanical Contractor at the time the concrete is poured to accommodate and anchor the equipment used. Coordinate with vibration isolation manufacturer's requirements and Section 22 and 23. Provide a one inch beveled edge all around.

1.18 BELT GUARDS:

A. Shall be provided, properly enclosing each belt drive system. Guards shall be easily removable, constructed of expanded metal with suitable frames corresponding with SMACNA standard and with tachometer openings. Coordinate with equipment suppliers to avoid duplication of belt guards supplied with equipment. Guards shall comply with OSHA Regulations.

1.19 ELECTRICAL WORK:

A. Power wiring to all electrically driven apparatus shall be done under the electrical contract. See Electrical Specifications.

B. Unless specifically noted otherwise on documents, Electrical Contractor shall furnish and install all magnetic starters including properly sized heaters, and disconnect switches as indicated on drawings or required by code.

C. The Contractor shall verify the proper operation of equipment furnished by him. Costs for repair, replacing, re-wiring and retesting shall be borne by the Contractor without additional costs to the Owner.

D. Motors shall be as specified.

1.20 CONTRACTOR'S USE OF BUILDING EQUIPMENT:

A. The Contractor may use equipment such as electric motors, fans, filters, etc. when permanently installed as part of the project and with the written permission of the Owner. As each piece of equipment is used, maintenance procedures approved by the manufacturer shall be followed, a careful record shall be kept of the time used, maintenance procedure following and of any difficulty experienced with equipment. The Contractor's records on the equipment shall be submitted to the Owner upon acceptance of project. All fan belts and filter media shall be new at the beginning of the Mechanical System Operating Test Run and System Balancing. Wearing surfaces (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement.

1.21 INSPECTION NOTICE:

A. The following is a basic list of guideline items so that the Architect, district building inspector/Owner's representative can be at job site for these inspections as the building progresses. Mechanical Contractor shall inform these people one week in advance of test time.

1. Water tests on all sewer, waste, and rainwater piping prior to piping being concealed.
2. Pressure tests on all water service piping.
3. Pressure tests on hot, chilled, and condenser water supply and return piping.
4. All duct work prior to installation of finished ceilings, including ductwork pressure testing.
5. The initial start-up of mechanical equipment, etc.
6. Any changes or problems occurring at job site.
7. Inspect all vent flashings on roof prior to roofing.
8. Periodic inspection at their discretion will be made to insure compliance to Contract Documents and codes. Contractor shall provide ladders, access and other assistance as requested during inspections.
9. Control piping pressure tests.
10. Final inspection before giving approval for final payment.

1.22 EXCAVATION AND BACKFILLING:

A. Trench for the underground gas pipe line shall be excavated to the required depth. Rocks, trash, or other debris will not be allowed in trench or backfill and shall be removed before pipe is laid in place. After piping has been tested, inspected and approved, piping shall be backfilled. All landscaping, concrete, etc., damaged by this Contractor shall be replaced by him to the satisfaction of Owner's Representative.

1.23 WARRANTY GUARANTEE:

A. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications as represented by manufacturer's published data.

B. The Contractor shall guarantee that the installation and operation of the equipment shall be free from defects for a period of one year beginning at date of substantial completion and acceptance. The Contractor shall replace or repair any part of the installation that is found to be defective or incomplete within the guarantee period.

C. The one year guarantee on equipment and systems shall commence when equipment has been demonstrated to work and has been accepted. (Example: If an equipment item fails to perform and it takes 9 months after substantial completion to correct, then the guarantee shall commence after the item has been demonstrated to perform and has been accepted.)

D. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.24 COMPLETION SCHEDULE:

A. Start-up and verification of basic equipment items shall be done prior to the date of substantial completion with sufficient time to allow balancing and adjusting to be performed.

B. At the time of the final inspection a date shall be agreed upon for completion of any remaining items. At least double the estimated cost of the work will be withheld from the Contractor's payment.

1.25 CODE REQUIREMENTS, FEES, AND PERMITS

A. The work shall be installed in accordance with the following applicable codes, ordinances and standards unless otherwise specified. The codes and standards shall include but not be limited to and be of the latest and current editions.

1. American Boiler and Affiliated Industries (AB and AI)
2. American Gas Association (AGA)
3. Air Movement and Control Association (AMCA)
4. American National Standards Institute (ANSI)
5. Air Conditioning & Refrigeration Institute (ARI)
6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - ASHRAE 90.1-219
7. American Society of Mechanical Engineers (ASME)
8. American Society of Testing Materials (ASTM)
9. American Standards Association (ASA)
10. American Water Works Association (AWWA)
11. American Welding Society (AWS)
12. Associated Air Balance Council (AABC)
13. Heat Exchange Institute (HEI)
14. Hydraulic Institute (HI)

15. BR
16. National Electrical Code (NEC)
17. National Fire Protection Association (NFPA)
18. Sheet Metal and Air Conditioning contractors National Association (SMACNA)
19. Underwriters Laboratories (UL)
20. International Building Code (IBC) 2021 Ed
21. International Mechanical Code (IMC) 2021 Ed
22. International Plumbing Code (IPC) with Utah Amendments 2021 Ed
23. International Energy Conservation Code (IECC) 2021 Ed
24. Utah State Safety Orders (OSHA/UOSH)
25. Utah Fire Rating Bureau
26. Utah Boiler and Pressure Vessel Law
27. Utah Air Conservation Regulations/Waste Disposal regulations.
28. ASHRAE Ventilation STD.62-219

B. Should drawings conflict with any code, the code shall govern. If drawings and specifications establish a quality exceeding the code, the drawings and specifications shall govern. If conflicts do exist among the drawings, specifications and codes, the same shall be brought to the attention of the Engineer in writing prior to bidding, otherwise Contractor shall comply with applicable codes.

C. The latest edition of all codes shall be used.

D. Contractor shall give all notices, obtain all necessary permits, file necessary plans, prepare documents and obtain approvals, and pay all fees required for completion of the mechanical and plumbing work outlined in this Division of the specifications and shown on the Mechanical Drawings.

1.26 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. Upon completion of work and before final payment, Contractor shall furnish and deliver to the Owner, through the Engineer, installation, operation and maintenance manuals with instructions for all new materials and equipment used in the building. The contractor shall provide three (2) hard copies of the manuals, and two (2) electronic copies of the manuals on CD or USB drive. Electronic information shall be .PDF format. The CD's shall include the same information as the hard copies, and shall be organized in the same manner with a table of contents and electronic bookmarks for each section. CD or USB drive itself shall be labeled the same as the hard copies of the manuals. Manuals may be assembled by the Div 22 or 23 contractor, by the TAB contractor, or by a third party such as Wasatch Manuals at Office: (801) 849-0442, Cell: (801) 674-9926, or Email: wasatchmanuals@gmail.com.

B. Bind Operation and Maintenance Manual for Mechanical Systems in a hard-backed three ring binder with strong sturdy cover. The project name shall be on the spine and the front of the binder. The front of the binder shall include the following information:

OPERATION
AND
MAINTENANCE

MANUAL
for MECHANICAL SYSTEMS of
(Name of Project)
(Location of Project)
(Date of Project Award)
(Name of Architect)

C. Introduction

1. Title page including name of project, project number, date awarded and date of substantial completion.
2. Second page shall contain the names, phone numbers and addresses of Architect, Consulting Engineers, Mechanical Contractor, and General Contractor.
3. Third page shall include a Table of Contents for the entire manual.

D. First Section - Summary information including:

1. First page shall contain the contractor's warranties.
2. Second page shall contain a list of names, addresses and phone numbers of contractors and all sub-contractors and work to which each was assigned.
3. Final page or pages shall contain an equipment list. The list shall contain each item of equipment or material for which a submittal was required giving ID or tag no as contained on the drawings make and model No. Serial No. Identification No. Location in building, function along with the name, address, and phone number of the supplier.

E. Second Section - Mechanical Equipment O&M data including:

1. Mechanical maintenance schedule, including a lubrication list when necessary.
2. Mechanical Equipment Operation and Maintenance Data including:

    a. Equipment descriptions
    b. Detailed installation instruction, operating and maintenance instructions. Instructions include in a step by step manner identifying start-up, operating, shutdown and emergency action sequence sufficiently clear so a person unfamiliar with the equipment could perform its operations.
    c. Equipment drawings, performance curves, operating characteristics, etc.
    d. Name addresses and phone number of manufacturer, fabricator and local vender clearly printed or stamped on cover.
    e. Complete parts listing which include catalog number, serial number, contract number or other accurate provision for ordering replacement and spare parts.
    f. Certified drawings, where applicable, showing assembly of parts and general dimensions.

3. Approved Mechanical submittals

F. Third Section - Plumbing Equipment O&M data including:

1. Section shall contain general product catalog cuts, as well as exploded view drawings with parts lists for all valves and other items with multiple parts.
2. Approved Plumbing submittals

G. Fourth Section - Controls O&M data including:

1. Sequence of Operation
2. Description of each operating system included location of switches, breakers, thermostats, and control devices. Provide a single line diagram, showing set points, normal operating parameters for all loads, pressures, temperatures and flow check points; Describe all alarms and cautions for operation.
3. Provide schematic control diagrams, panel diagrams, wiring diagrams, etc. for each separate fan system, chilled water system, hot water system, exhaust air system, pumps, etc. Each control diagram shall show a schematic representation of mechanical equipment and location of start-stop switches, insertion thermostats, thermometers, pressure gauges, automatic valves, etc. The correct reading for each control instrument shall be marked on the diagram.

H. The Fifth Section shall contain a complete air and water test and balance report. The report shall contain the name, address and phone number of the agency. It shall also include:

1. Floor plans showing all air openings and thermometer locations clearly marked and cross referenced with data sheets. Format may be 8 1/2 x 11 or 11x14 if legible.
2. Data sheets showing amount of air and water at each setting. See sections 230593.
3. List of equipment with date of last calibration.

I. Drawings and reproducible masters of drawings as required in individual specification sections, are not to be bound in volumes but are to be delivered separate with the maintenance manuals.

J. See the following checklist for assistance in assembling manual:

Item #	Description	Y, N, or NA
1.	3 ring heavy duty binder with Project name, number and date on cover and project name on spine.	
2.	O&M manual on CD (with label on CD matching label on manual). Electronic copy shall be a PDF file with bookmarks that match the tabs in the hard copy.	
3.	Title Page [including project name, number, address, date awarded, date of substantial completion]	
4.	Second Page Contact List [including architect (if applicable), mechanical engineer, mechanical contractor, and general	

	contractor (if applicable)]	
5.	Table of Contents	
6.	Section 1 - Summary	
A.	Warranty	
B.	Mechanical's Sub-contractor List	
C.	Vendor List	
D.	Equipment List	
7.	Section 2 – Mechanical Equipment	
A.	Maintenance Schedule (including lubrication list)	
B.	Mechanical Equipment O&M Data (for each piece of equipment submitted) per specifications	
C.	Approved mechanical submittals	
8.	Section 3 – Plumbing Equipment	
A.	Plumbing equipment O&M data	
B.	Approved plumbing submittals	
9.	Section 4 - Controls	
A.	Sequence of Operation	
B.	Controls diagrams	
C.	Controls Equipment	
10.	Section 5 – Test and Balance Report	
A.	Complete Test and Balance Report per specifications	

1.27 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems utilizing the Operation and Maintenance Manual when so doing.

B. Minimum instruction periods shall be as follows -

1. Mechanical - Four hours.
2. Plumbing - Two hours.
3. Temperature Control - Eight hours.

C. Instruction periods shall occur before final site observation when systems are properly working and before final payment is made.

D. None of these instructional periods shall overlap each other.

E. An additional four hours of instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and answer questions.

1.28 RECORD DRAWINGS

A. Contractor shall keep an up-to-date set of mechanical and plumbing drawings in his custody showing all changes in red, clearly defined and neatly drafted by him. At the end of construction, he shall turn these drawings over to the Engineer. Record drawings must be completed and submitted prior to final site observation

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PART 2 - PRODUCTS
(Not Used)

PART 3 - EXECUTION
(Not Used)

END OF SECTION 220100

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DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 220500 – BASIC PLUMBING AND HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Mechanical demolition.
7. Equipment installation requirements common to equipment sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. All materials, piping, etc. shall be new, and domestically made of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended unless specifically approved in writing prior to bid.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 and 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.
h. Prior Approved Equal.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
e. Linkseal.
f. Prior Approved Equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

E. PVC Pipe: ASTM D 1785, Schedule 40.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 and 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Drawings do not show every offset, or bend that may be required. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors where indicated on drawings and where penetrating will be visible to public.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 and 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.

6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 220500

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with

indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220513

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SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

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. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flo Fab inc.
b. Miljoco Corporation.

c. Palmer Wahl Instrumentation Group.
d. Tel-Tru Manufacturing Company.
e. Trerice, H. O. Co.
f. Weiss Instruments, Inc.
g. Weksler Glass Thermometer Corp.
h. Winters Instruments - U.S.

2. Standard: ASME B40.200.

3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: plastic.
8. Stem: Aluminum and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ametek U.S. Gauge.
b. Ashcroft Inc.
c. Ernst Flow Industries.
d. Flo Fab inc.
e. Marsh Bellofram.
f. Miljoco Corporation.
g. Noshok.
h. Palmer Wahl Instrumentation Group.
i. REOTEMP Instrument Corporation.
j. Tel-Tru Manufacturing Company.
k. Trerice, H. O. Co.
l. Watts; a Watts Water Technologies company.
m. Weiss Instruments, Inc.
n. Weksler Glass Thermometer Corp.
o. WIKA Instrument Corporation.
p. Winters Instruments - U.S.

2. Standard: ASME B40.100.

3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: plastic.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flow Design, Inc.
2. Miljoco Corporation.
3. Peterson Equipment Co., Inc.

4. Sisco Manufacturing Company, Inc.
5. Trerice, H. O. Co.
6. Watts; a Watts Water Technologies company.
7. Weiss Instruments, Inc.
8. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each temperature changing piece of equipment

L. Install pressure gages in the following locations:
   1. Inlet and outlet of each device or piece of equipment with a pressure drop

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 220519

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SECTION 220523 – GENERAL- DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following general-duty valves:

1. Bronze ball valves.
2. Ferrous-alloy ball valves.
3. Ferrous-alloy butterfly valves.
4. Bronze check valves.
5. Ferrous-alloy wafer check valves.
6. Chainwheel actuators.

B. Related Sections include the following:
1. Division 22 and 23 Section "Mechanical Identification" for valve tags and charts.
2. Division 22 and 23 Section "HVAC Instrumentation and Controls" for control valves and actuators.
3. Division 22 and 23 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NRS: Nonrising stem.
4. OS&Y: Outside screw and yoke.
5. PTFE: Polytetrafluoroethylene plastic.
6. SWP: Steam working pressure.
7. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

C. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

D. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

G. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
3. Handwheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

H. Valves in Insulated Piping: Valves shall have 2-inch stem extensions and the following features:

1. Ball Valves: Shall have extended operating handle of non-thermal-conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.

    a. Manufactures: NIBCO Nib-seal handle extension or a comparable product by one of the following:

        1) Conbraco Industries, Inc.; Apollo Div.
        2) American.
        3) Crane.
        4) Grinnel.
        5) Kitz.
        6) Watts.
        7) Prior approved equal.

2. Butterfly Valves: Shall have extended necks.

I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

J. Solder Joint: With sockets according to ASME B16.18.

1. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

K. Threaded: With threads according to ASME B1.20.1.

L. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: Chrome-plated bronze ball and bronze stem and; reinforced TFE seats; threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, solder or threaded ends; and 150 psig SWP 600-psigCWP rating.

1. Manufacturers: NIBCO Model S-585-70 or T-585-70, or a comparable product by one of the following:

a. NIBCO Model S-585-70 or T-585-70
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Div.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Grinnell Corporation.
g. Kitz Corporation of America.
h. NIBCO INC.
i. Watts Industries, Inc.; Water Products Div.

C. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, reinforced TFE seats, threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, soldered or threaded ends; 150 psig SWP and 600-psig CWP ratings.

1. Manufacturers: NIBCO Model S-585-70-66 or T-585-70-66, or a comparable product by one of the following:

a. Conbraco Industries, Inc.; Apollo Div.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Div.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Grinnell Corporation.
g. Kitz Corporation of America.
h. NIBCO INC.
i. Watts Industries, Inc.; Water Products Div.

2.4 FERROUS-ALLOY BALL VALVES

A. Ferrous-Alloy Ball Valves, General: MSS SP-72, with ASTM A-216 Type WCB, carbon-steel body; ASTM A-351, Type CF8M vented stainless-steel ball; and ASTM A-276, Type 316

stainless-steel stem; fire rated according to API 607 (4th edition); and having flanged ends and blowout-proof stem.

B. Class 150, Full-Port, Ferrous-Alloy Ball Valves: Split-body construction, carbon-filled TFE seats; 285 psig CWP rating.

1. Manufacturers:

a. NIBCO Model F-515-CS-F-66-FS.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Div.
d. Cooper Cameron Corp.; Cooper Cameron Valves Div.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Foster Valve Co.
g. Hammond Valve.
h. Jomar International, LTD.
i. Kitz Corporation of America.
j. Milwaukee Valve Company.
k. Watts.

2.5 FERROUS-ALLOY BUTTERFLY VALVES

A. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, grooved and flanged valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange. Valves NPS 12 and smaller shall not have exposed stem to disc fasteners and no exterior mounted fasteners to hold the liner.
2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Single-Flange, 150-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, aluminum-bronze disc, and phenolic-backed EPDM seat (liner) attached to the body.

1. Manufacturers: NIBCO Model LD-1000-5, or a comparable product by one of the following:

a. Bray International, Inc.
b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
c. Crane Co.; Crane Valve Group; Center Line.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Dover Corp.; Dover Resources Company; Norriseal Div.
g. General Signal; DeZurik Unit.
h. Grinnell Corporation.

i. Hammond Valve.
j. Kitz Corporation of America.
k. Legend Valve & Fitting, Inc.
l. Metraflex Co.
m. Milwaukee Valve Company.
n. Mueller Steam Specialty.
o. Process Development & Control.
p. Red-White Valve Corp.
q. Techno Corp.
r. Tyco International, Ltd.; Tyco Valves & Controls.
s. Watts Industries, Inc.; Water Products Div.

C. Single-Flange, 150-psig CWP Rating, Aluminum-Bronze Disc, BUNA Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, aluminum-bronze disc, and phenolic-backed BUNA seat (liner) attached to the body.

1. Manufacturers: NIBCO Model LD-1100-5, or a comparable product by one of the following:

a. Bray International, Inc.
b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
c. Crane Co.; Crane Valve Group; Center Line.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Dover Corp.; Dover Resources Company; Norriseal Div.
g. General Signal; DeZurik Unit.
h. Grinnell Corporation.
i. Hammond Valve.
j. Kitz Corporation of America.
k. Legend Valve & Fitting, Inc.
l. Metraflex Co.
m. Milwaukee Valve Company.
n. Mueller Steam Specialty.
o. Process Development & Control.
p. Red-White Valve Corp.
q. Techno Corp.
r. Tyco International, Ltd.; Tyco Valves & Controls.
s. Watts Industries, Inc.; Water Products Div.

2.6 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Lift Check Valves with TFE Disc: ASTM B-584 bronze body and integral seat with soldered or threaded end connections, and having 250-psig CWP rating.

1. Manufacturers: NIBCO Model S-480-Y or T-480-Y, or a comparable product by one of the following:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Red-White Valve Corp.
e. Walworth Co.

C. Class 125, Bronze, Lift Check Valves with BUNA Disc: ASTM B-584 bronze body and integral seat with nonmetallic BUNA disc, soldered or threaded end connections, and having 250-psig CWP rating.

1. Manufacturers: NIBCO Model S-480 or T-480, or a comparable product by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Powell, Wm. Co.

D. Class 125, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.

1. Manufacturers: NIBCO Model S-413-Y or T-413-Y, or a comparable product by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Powell, Wm. Co.

E. Class 125, Bronze, Swing Check Valves with BUNA Disc: ASTM B-62 bronze body and seat with BUNA disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.

1. Manufacturers: NIBCO Model S-413-W or T-413-W, or a comparable product by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Powell, Wm. Co.

F. Class 150, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.

1. Manufacturers: NIBCO Model S-433-Y or T-433-Y, or a comparable product by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Powell, Wm. Co.

2.7 DUAL-PLATE, IRON, WAFER OR GROOVED CHECK VALVES

A. Dual-Plate, Iron, Wafer or Grooved Check Valves, General: ANSI B16.1, spring loaded.

B. Dual-Plate, Iron, Wafer or Grooved Check Valves: Class 125, cast-iron, flangeless body with dual, bronze discs; stainless-steel spring and stop pin; BUNA seat; and having 200 psig CWP rating.

1. Manufacturers: NIBCO Model W-920-W or G-920-W, or a comparable product by one of the following:

a. Metraflex Co.
b. Val-Matic Valve & Mfg. Corp.
c. Crane.
d. Grinnel.
e. Mueller.
f. Watts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or butterfly valves.
2. Throttling Service: Angle, ball, butterfly, or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc or dual-plate check valves; lever and weight swing check valves; or lever and spring swing check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Domestic Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, bronze.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full -port, ferrous alloy.
3. Butterfly Valves, NPS 2 to NPS 12 Single-flange, full lug, 200-psig CWP rating, bronze disc, EPDM liner, ferrous alloy.
4. Lift Check Valves, NPS 2 and Smaller: Class 125 , bronze with TFE disc.

D. Heating Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full -port, ferrous alloy.
3. Butterfly Valves, NPS 2 to NPS 12 Single-flange, full lug, 200-psig CWP rating, bronze disc, EPDM liner, ferrous alloy.
4. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2 to NPS 8: 300-psig CWP rating, EPDM- encapsulated ductile-iron disc.
5. Grooved-End, Ductile-Iron Butterfly Valves, NPS 10 to NPS 12: 200-psig CWP rating, EPDM- encapsulated ductile-iron disc.
6. Dual-Plate Check Valves, NPS 2-1/2 and Larger: Wafer, iron.

E. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves may be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

G. Butterfly valves shall be installed with stems horizontal.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 and 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Fastener systems.

B. Related Sections include the following:
1. Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Available Manufacturers:

1. AAA Technology & Specialties Co., Inc.
2. Bergen-Power Pipe Supports.
3. B-Line Systems, Inc.; a division of Cooper Industries.
4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co.
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
10. National Pipe Hanger Corporation.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. Tolco Inc.
15. Or equal

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Available Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.
7. Or equal

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. Hilti, Inc.
b. ITW Ramset/Red Head.
c. Masterset Fastening Systems, Inc.
d. MKT Fastening, LLC.
e. Powers Fasteners.
f. Or equal

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.
g. Or equal

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

N. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

D. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

K. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 PAINTING

A. Touch Up: 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.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Freestanding and restrained spring isolators.
   3. Seismic snubbers.
   4. Restraining braces and cables.

1.3 SCOPE

A. Provide letter of design intent.

B. Provide full set of seismic submittals.

C. Provide a minimum of 2 on site observations.

D. Provide final letter of compliance completion.

1.4 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.5 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:
   1. Basic Wind Speed: Per owner's design standards.
   2. Building Classification Category: As defined in the IBC.
   3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:
   1. Site Class: As defined in the IBC.
   2. Assigned Seismic Use Group or Building Category: As defined in the IBC.

a. Component Importance Factor: 1.0.

1.6 SUBMITTALS

A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. 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 evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Letter of Design intent, stating company, design criteria, compliance with specifications and only exceptions that will apply. Letter shall be stamped and signed by a licensed and qualified professional engineer in this jurisdiction.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, 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 Division 22 and 23 Sections for equipment mounted outdoors.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
   3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
   4. Seismic- and Wind-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic and wind 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 spacing's. 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 Division 22 and 23 Sections for equipment mounted outdoors.
d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Welding certificates.

F. Qualification Data: For professional engineer and testing agency.

G. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. 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) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Provide a minimum of 2 site observations, and additional observations if required.

F. Upon project completion provide a final letter of acceptance for seismic restraints system and installation.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Vibro-acoustics.
   3. ISAT
   4. Mason Industries.
   5. Caddy
   6. Prior approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Hilti, Inc.
   3. ISAT
   4. Kinetics Noise Control.
   5. Mason Industries.
   6. Vibro-acoustics.
   7. Gripple.
   8. Unistrut; Tyco International, Ltd.
   9. Prior approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
   2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: -steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

G. 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.

H. 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.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. 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. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl 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.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of 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 Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or 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 due to 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 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:
   1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. 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.

G. 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.

H. 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 piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Leave a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. 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.
   6. Measure isolator restraint clearance.
   7. Measure isolator deflection.
   8. Verify snubber minimum clearances.
   9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 220548

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SECTION 220553 - IDENTIFICATION FOR MECHANICAL AND PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment signs.
3. Access panel and door markers.
4. Pipe markers.
5. Warning tags.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

a. Manufacturer, product name, model number, and serial number.
b. Capacity, operating and power characteristics, and essential data.
c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.
2. Engraving: Manufacturer's standard letter style, 1/4" or larger with terms to match equipment identification.
3. Thickness: 1/8 inch, unless otherwise indicated.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

C. Access Panel and Door Markers: 1/16" thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8" center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Bradley.
b. Kolbi.
c. Prior approved.

2. Colors: Comply with ASME A13.1, unless otherwise indicated.

3. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, furnaces, heaters, etc.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HVAC central-station and zone-type units.

B. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with black equipment markers with white lettering.
2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
4. Include signs for the following general categories of equipment:

a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
b. Fuel-burning units, including boilers, furnaces, heaters, etc.
c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
e. Fans, blowers, primary balancing dampers, and mixing boxes.
f. Packaged HVAC central-station and zone-type units.
g. Tanks and pressure vessels.
h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.4 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 220553

SECTION 220700 - HVAC AND PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

    a. Mineral fiber.

2. Insulating cements.
3. Adhesives.
4. Lagging adhesives.
5. Factory-applied jackets.
6. Field-applied jackets.
7. Tapes.
8. Securements.
9. Corner angles.

B. Related Sections:

1. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 and 23 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors. Provide a weather protective sheet metal jacket for outdoor installation.

2. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; All-Service Duct Wrap.
f. Prior approved equal.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
f. Prior approved equal.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
c. Prior approved equal.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-127.
b. Foster Products Corporation, H. B. Fuller Company; 85-60/ 85-70.
c. Marathon Industries, Inc.; 225.
d. Mon-Eco Industries, Inc.; 22-25.
e. Prior approved equal.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of H.B. Fuller; CR 50 AHV2.
b. Foster Products Corporation, H. B. Fuller Company; 30-36.
c. Vimasco Corporation; 713 and 714.
d. Prior approved equal.

2. Service Temperature Range: Minus 50 to plus 180 deg F.
3. Color: White.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
b. Compac Corp.; 104 and 105.
c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
8. Adhesion: 64 ounces force/inch in width.
9. Elongation: 500 percent.
10. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.

d. Venture Tape; 3520 CW.
e. Prior approved equal.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.
d. Prior approved equal.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.8 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by

tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return, Air.
4. Indoor, exposed return, Air.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, concealed exhaust.
7. Indoor, exposed exhaust.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Concealed, low pressure, round rectangular, and flat-oval exhaust-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Rectangular, low pressure, supply-air duct insulation shall be lined per Section "Metal Ducts".

D. Rectangular, return-air duct insulation shall be lined per Section "Metal Ducts".

E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

F. Exposed or medium pressure, round and flat-oval, supply-air, and return air duct insulation shall be a perforated linear. See Section "Metal Ducts".

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
4. Vertical roof drain piping.

C. Piping System insulation:

1. Hydronic Piping - Mineral Fiber, per chart.
2. Domestic Cold Water Piping -Mineral Fiber, ½"
3. Domestic Hot Water Piping -Mineral Fiber, per chart
4. Horizontal Roof Drain Piping - Mineral Fiber, 1/2".
5. Refrigerant Piping - Flexible elastomeric, 1".

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Minimum Pipe Insulation Thickness per 2021 IECC

Fluid Operating Temperature Range and usage (F°)	Insulation Conductivity		Nominal Pipe or Tube Size (inches)				
	Conductivity Btu-in./(h-ft²-F°)	Mean Rating Temp. F°	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)							
>350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.21-0.28	100	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine, and Refrigerant)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20-0.26	50	0.5	1.0	1.0	1.0	1.5

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed in mechanical room:

1. PVC: 20 mils thick and color coded

D. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2019, with modifications per 2021 IECC

3.13 DUCT INSULATION SCHEDULE

A. Minimum Duct Insulation R-Value, Cooling and Heating Supply Ducts and Return Ducts ANSI/ASHRAE/IES Standard 90.1-2019.

Duct Location							
Climate Zone	Exterior	Ventilated Attic	Unvented Attic Above Insulated Ceiling	Unvented Attic with Roof Insulation	Unconditioned Space	Indirectly Conditioned Space	Buried
Heating- Only Ducts							
5	R-6	R-3.5	none	none	none	none	R-3.5
Cooling-Only Ducts							
5,6	R-3.5	R-1.9	R-3.5	R-1.9	R-1.9	none	none
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none
Combine Heating and Cooling							
Supply Ducts							
5	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none

3.14 OUTDOOR, FIELD APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Exterior piping, Exposed:

1. Aluminum jacket.

END OF SECTION 220700

SECTION 220800 - COMMISSIONING OF PLUMBING

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 Cx process requirements for the following plumbing systems, assemblies, and equipment:

1. Domestic hot- and cold-water piping.
2. Sanitary waste and vent piping.
3. Storm drainage piping.
4. Rainwater retention piping and equipment.
5. Plumbing pumps.
6. General-service compressed-air piping and equipment.
7. Plumbing equipment.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 22 Sections specifying plumbing systems, system components, equipment, and products.

1.3 DEFINITIONS

A. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

B. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

C. IAPMO: International Association of Plumbing and Mechanical Officials.

D. IGCC: International Green Construction Code.

E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For plumbing testing technician.

B. Construction Checklists:

1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Contractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.

C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Contractor, provide the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

a. Instrument or tool identification number.
b. Equipment schedule designation of equipment for which the instrument or tool is required.
c. Manufacturer, make, model, and serial number.
d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.5 QUALITY ASSURANCE

A. Plumbing Testing Technician Qualifications: Technicians to perform plumbing Construction Checklist verification tests. Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of plumbing system, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Medical Gas Piping Systems Testing Technician Qualifications: Technicians to perform medical compressed-air, vacuum, and medical gas piping for laboratory and healthcare facilities system Construction Checklist verification tests. Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in mechanical systems, plumbing systems, or similar field. Degree requirement may be offset by three years' experience in

servicing plumbing systems and gas piping for laboratory and healthcare facilities. Generally, required knowledge includes design and maintenance of gas piping for laboratory and healthcare facility systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of plumbing system equipment, assemblies, and systems.

2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

a. Be calibrated by manufacturer with current calibration tags permanently affixed.
b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
c. Plumbing system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Cx PROCESS:

A. Perform Cx process for plumbing systems in accordance with:

1. ASHRAE 202.
2. DFCM High Performance Building Standard
3. Commissioning standards acceptable to the authority having jurisdiction.

3.2 Cx TESTING PREPARATION

A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that plumbing system instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and that all systems are set to and maintaining set points as required by the design documents.

C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.3 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 Cx TESTS COMMON TO PLUMBING SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response compared to acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 22 Sections specifying plumbing systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.
2. Cx Construction Checklist verification test demonstrations.

END OF SECTION 220800

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SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

a. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
b. Flexible connectors.
c. Escutcheons.
d. Sleeves and sleeve seals.
e. Wall penetration systems.

B. Related Section:

a. Division 2 Section "Water Distribution" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall with stand effects of earthquake motions determined according to 2006 IBC.

1.4 SUBMITTALS

A. Product Data: For the following products:

a. Specialty valves.
b. Transition fittings.
c. Dielectric fittings.
d. Flexible connectors.
e. Water meters.
f. Backflow preventers and vacuum breakers.
g. Escutcheons.
h. Sleeves and sleeve seals.
i. Water penetration systems.

B. Water Samples: Specified in "Cleaning" Article.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

a. Fire-suppression-water piping.
b. Domestic water piping.
c. Compressed air piping.
d. HVAC hydronic piping.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

a. Notify Owner no fewer than two days in advance of proposed interruption of water service.
b. Do not proceed with interruption of water service without Owner's written permission.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

a. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.

b. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

c. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
d. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

C. Pro-press fittings by
a. Viega
b. Nibco
c. Prior approved equal

2.4 TRANSITION FITTINGS

A. General Requirements:

a. Same size as pipes to be joined.
b. Pressure rating at least equal to pipes to be joined.
c. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type or Split-Sleeve Type Transition Coupling: AWWA C219.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Dresser Piping Specialties.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc; a Sensus company.
g. Victaulic/Depend-O-Lok®
h. Viking Johnson; c/o Mueller Co.
i. Prior approved equal.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products.
g. Prior approved equal.

b. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Prior approved equal.

b. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.
e. Prior approved equal.

b. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Perfection Corporation; a subsidiary of American Meter Company.
b. Victaulic Company.
c. Prior approved equal.

b. Electroplated steel or ductile iron nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and maximum working pressure at. 300 psi and maximum operating temperature of 230 deg F.

2.6 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.

E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew or spring clips.

G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.7 SLEEVES

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

F. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with setscrews.

2.8 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex, Inc.
d. Pipeline Seal and Insulator, Inc.
e. Prior approved equal.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.

a. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
b. Pressure Plates: Carbon steel.
c. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.9 WALL PENETRATION SYSTEMS

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:

a. SIGMA.
b. Prior approved equal.

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.

a. Carrier-Pipe Deflection: Up to 5 percent without leakage.
b. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.

c. Housing-to-Sleeve Gasket: EPDM rubber.
d. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
e. Pipe Sleeve: AWWA C151, ductile-iron pipe.

2.10 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Section "Meters and Gages for Plumbing Piping" for pressure gages and Section "Domestic Water Piping Specialties" for drain valves and strainers.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Section "Domestic Water Piping Specialties" for pressure-reducing valves.

H. Install domestic water piping level without pitch and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install seismic restraints on piping. Comply with requirements in Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping adjacent to equipment and specialties to allow service and maintenance.

O. Install piping to permit valve servicing.

P. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

Q. Install piping free of sags and bends.

R. Install fittings for changes in direction and branch connections.

S. Install PEX piping with loop at each change of direction of more than 90 degrees.

T. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

U. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Section "Meters and Gages for Plumbing Piping" for pressure gages.

V. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

W. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 and 23 Section "Meters and Gages for Plumbing Piping" for thermometers.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 and 23 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 and 23 Section "Domestic Water Piping Specialties."

a. Hose-End Drain Valves: At low points in water mains, risers, and branches.
b. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

a. NPS 1-1/2 and Smaller: Fitting-type coupling.
b. NPS 2 and Larger: Sleeve-type coupling.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 and 23 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

a. Vertical Piping: MSS Type 8 or 42, clamps.
b. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.

c. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
d. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

a. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
b. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
c. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
d. NPS 2-1/2: 108 inches with 1/2-inch rod.
e. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
f. NPS 6: 10 feet with 5/8-inch rod.
g. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install supports for vertical steel piping every 15 feet.

H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.9 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

a. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
b. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
c. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 and 23 plumbing fixture Sections for connection sizes.
d. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.10 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
d. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw or spring clips.
e. Bare Piping in Equipment Rooms: One piece, stamped steel with set screw or spring clips.
f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

C. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
b. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with exposed-rivet hinge and set screw or spring clips.
f. Bare Piping in Equipment Rooms: Split plate, stamped steel with set screw or spring clips.
g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.11 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

a. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.

    a. Extend sleeves 2 inches above finished floor level.
    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 7 Section "Sheet Metal Flashing and Trim" for flashing.

c. Sleeves for Piping Passing through Gypsum-Board Partitions:

    a. PVC pipe sleeves for pipes smaller than NPS 6.
    b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
    c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

d. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe Insert type.
e. Sleeves for Piping Passing through Exterior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.
    b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
    c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
    d. Do not use sleeves when wall penetration systems are used.

f. Sleeves for Piping Passing through Interior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.
    b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestop materials and installations.

3.12 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.13 WALL PENETRATION SYSTEM INSTALLATION

A. Install wall penetration systems in new, exterior concrete walls.

B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.14 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 and 23 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.15 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

d. Cap and subject piping to static water pressure of 100 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.16 ADJUSTING

A. Perform the following adjustments before operation:

a. Close drain valves, hydrants, and hose bibbs.
b. Open shutoff valves to fully open position.
c. Open throttling valves to proper setting.
d. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
b. Adjust calibrated balancing valves to flows indicated.

e. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
f. Remove and clean strainer screens. Close drain valves and replace drain plugs.
g. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
h. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.17 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
b. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:

a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
b. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.18 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges, and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be the following:

a. Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:

a. Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
b. Mechanical-joint, ductile-iron pipe; standard- pattern mechanical-joint fittings; and mechanical joints.

E. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:

a. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints or pro-press fittings.

F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

a. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints or pro-press fittings.

3.19 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

a. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
b. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
c. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
d. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

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SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

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. Vacuum breakers.
2. Strainers.
3. Hose bibbs.
4. Drain valves.
5. Circuit Setters

1.3 PERFORMANCE AND REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ames Co.
    b. Cash Acme.
    c. Conbraco Industries, Inc.
    d. FEBCO; SPX Valves & Controls.
    e. Rain Bird Corporation.
    f. Toro Company (The); Irrigation Div.
    g. Watts Industries, Inc.; Water Products Div.
    h. Zurn Plumbing Products Group; Wilkins Div.
    i. Prior approved equal.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Arrowhead Brass Products, Inc.
    b. Cash Acme.
    c. Conbraco Industries, Inc.
    d. Legend Valve.
    e. MIFAB, Inc.
    f. Prier Products, Inc.
    g. Watts Industries, Inc.; Water Products Div.
    h. Woodford Manufacturing Company.
    i. Zurn Plumbing Products Group; Light Commercial Operation.
    j. Zurn Plumbing Products Group; Wilkins Div.
    k. Prior approved equal.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated

2.2 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Drain: Factory-installed, hose-end drain valve.

2.3 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.4 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: 1.5"
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple cap with brass chain.

2.5 CIRCUIT SETTERS

A. Domestic Hot Water Recirc circuit setters shall be thermostatic balance valves. Shall be one of the following manufacturers:

1. Bell and Gossett Temp Setter or equal by:

2. Caleffi
3. Prior Approved Equal.

2.6 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.
   g. Prior approved equal.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Accessories:

   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc; Water Products Div.
   c. Woodford Manufacturing Company.
   d. Prior Approved Equal.

2.7 WATER PRESSURE- REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   d. Watts Industries, Inc; Water Products Div.

e. Zurn Plumbing Products Group; Wilkins Div.
f. Prior approved equal.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.8 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Electronic, Water Mixing Valves:

1. Approved Manufacturers:
   a. Acorn Basyc
   b. Armstrong Brain
   c. Caleffi
   d. Watts
   e. Prior approved equal

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed, electronically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or solder joint inlets and outlets.
7. Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
8. Tempered-Water Setting: 120.
9. Pressure Drop at Design Flow Rate: 10.
10. Valve Finish: Bronze.
11. Digital temperature control and monitoring module.

    a. Controls temperature within plus or minus 2 deg F.
    b. User programmable at module or through BAS.
    c. ASHRAE 188 compliance.
    d. Local and remote monitoring.
    e. BACNet protocol language(s).
    f. 115 V ac, 60 Hz.
    g. Battery backup.

B. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sloan
   b. Watts
   c. Prior approved equal

2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 110□ F.

2.9 WALL HYDRANTS

A. Non freeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. Josam Company.
   c. Prier Products, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Woodford Manufacturing Company.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
   j. Or equal by.

B. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.

1. Pressure Rating: 125 psig (860 kPa).
2. Operation: Loose key.
3. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
4. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
5. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
6. Box: Deep, flush mounting with cover.
7. Box and Cover Finish: Chrome plated.
8. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
9. Nozzle and Wall-Plate Finish: Polished nickel bronze.
10. Operating Keys(s): Two with each wall hydrant.

C. Vacuum Breaker Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Arrowhead Brass Products, Inc.
   b. Mansfield Plumbing Products LLC.
   c. McDonald, A. Y. Mfg. Co.
   d. Prier Products, Inc.
   e. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Watts Industries, Inc.; Water Products Div.

g. Woodford Manufacturing Company.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Or equal by.

2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig (860 kPa).
6. Operation: Loose key.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.10 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. PPP Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products Inc.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
   j. Or equal by.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.11 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.12 CIRCUIT SETTERS

A. Domestic Hot Water Recirc circuit setters shall be thermostatic balance valve. Shall be one of the following manufacturers.

    a. Bell and Gossett Temp Setter or equal by:
    b. Caleffi
    c. Prior approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 and 23 Section "Common work results" for piping joining materials, joint construction, and basic installation requirements.
B. Revise remaining paragraphs and subparagraphs in this Article to include specific installation requirements.
C. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
B. Test each reduced-pressure-principal backflow preventer according to authorities having jurisdiction and the device's reference standard.
C. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.
B. Set field-adjustable flow set points of balancing valves.
C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:

1. Wet Rotor Circulators.

1.3 SUBMITTALS

A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For domestic water pumps to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 100% LEAD-FREE WET ROTOR CIRCULATORS

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Industries.
3. Grundfos Pumps Corp.
4. Taco, Inc.
5. Prior approved equal.

B. Description:

1. In-line wet rotor circulation pumps designed specifically for quiet operation in open (potable) water systems. Pumps shall have 100% lead-free bronze or stainless steel bodies.
2. Provide with Aquastat.

C. Construction Materials:

1. Pump Body:

a. NBF: 100% lead-free bronze.
b. SSF: Stainless Steel.

2. Bearings: Carbon
3. Impeller:

a. NBF-33, NBF-36, NBF-45: Noryl.
b. All Others: Polypropylene.

4. Shaft: Ceramic

D. Operating Data

1. Maximum Working Pressure: 150 psi (10.3 Bar)
2. Maximum Operating Temperature:

a. NBF-33, NBF-36, NBF-45: 225EF.
b. All Others: 230EF.

E. Capacities and Characteristics: See drawings.

2.3 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Manufacturers:

a. Honeywell International, Inc.
b. Square D.
c. White-Rodgers Div.; Emerson Electric Co.
d. Prior approved equal.

2. Type: Water-immersion sensor, for installation in hot-water circulation piping.
3. Range: 65 to 200 deg F.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V, ac or 120 V, ac.

2.4 BUILDING-AUTOMATION-SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of 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.

3.3 CONTROL INSTALLATION

A. Install immersion-type thermostats in hot-water return piping.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 and 23 Section "Domestic Water Piping."

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

    a. Separately coupled, in-line centrifugal pumps.
    b. Separately coupled, horizontally mounted, in-line centrifugal pumps.
    c. Close-coupled, horizontally mounted, in-line centrifugal pumps.
    d. Close-coupled, vertically mounted, in-line centrifugal pumps.

2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 and 23 Section "Valves" for general-duty valves for domestic water piping and Division 22 and 23 Section "Plumbing Specialties" for strainers.
3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 22 and 23 Section "Meters and Gages" for pressure gages and gage connectors.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. Connect thermostats to pumps that they control.

G. Interlock pump with water heater burner and time delay relay.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set thermostats for automatic starting and stopping operation of pumps.
5. 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 the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 221123

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SECTION 221316- SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

B. Related Sections:

1. Division 2 Section "Sanitary Sewerage" for sanitary sewerage piping and structures outside the building.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than 72 hours in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Fernco Inc.
c. MIFAB, Inc.
d. Tyler Pipe.
e. Ideal
f. Prior approved equal.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ANACO-Husky.
    b. MIFAB, Inc.
    c. Tyler Pipe.
    d. Ideal
    e. Prior approved equal.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Dallas Specialty & Mfg. Co.
        2) Fernco Inc.
        3) Mission Rubber Company; a division of MCP Industries, Inc.
        4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
        5) Prior approved equal.

b. Standard: ASTM C 1173.
c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company; a division of MCP Industries, Inc.
3) Prior approved equal.

b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following.

1) Cascade Waterworks Mfg. Co.
2) Dresser, Inc.
3) EBAA Iron, Inc.
4) JCM Industries, Inc.
5) Romac Industries, Inc.
6) Smith-Blair, Inc; a Sensus company.
7) The Ford Meter Box Company, Inc.
8) Viking Johnson.
9) Prior approved equal.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 2 Section "Earthwork."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and

calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install aboveground ABS piping according to ASTM D 2661.

P. Install aboveground PVC piping according to ASTM D 2665.

Q. Install underground ABS and PVC piping according to ASTM D 2321.

R. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

S. Plumbing Specialties:

1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."

T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 and 23 Section "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 and 23 Section "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 and 23 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
b. NPS 2and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 and 23 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 and 23 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting[, valve,] and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for backwater valves cleanouts and drains specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 and 23 Section "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste and vent piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

C. Underground, soil, waste, and vent piping shall be any of the following:

1. Extra Heavy class, cast-iron soil piping; calking materials; and calked joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Air-admittance valves.
4. Trap Guards.
5. Roof flashing assemblies.
6. Miscellaneous sanitary drainage piping specialties.
7. Flashing materials.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer, rated capacities, operating characteristics, and accessories for the following:

1. Cleanouts.
2. Floor drains.
3. Air admittance valves.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation.
    g. Prior approved equal.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Commercial Enameling Co.

b. Josam Company; Josam Div.
c. MIFAB, Inc.
d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products Inc.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn Plumbing Products Group; Specification Drainage Operation.
j. Prior approved equal.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Top or Strainer Material: Chrome plate
8. Top or Strainer Material: Stainless steel for shower drains
9. Top Shape: Round.
10. Top Loading Classification: Medium Duty.
11. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
12. Trap Pattern: Deep-seal P-trap.
13. Trap Features: Trap-seal primer valve drain connection.

2.3 AIR-ADMITTANCE VALVES

A. Wall Box:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Durgo, Inc.
b. Oatey.
c. RectorSeal.
d. Studor, Inc.
e. Prior approved equal.

2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.
c. Prior approved equal.

B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. NPS 2: 4-inch- minimum water seal.
b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Trap Guard

1. Description: Trap guard shall have flexible elastomeric material open on top, with curl closure on bottom as needed to allow water to flow, but not allow sewer gases to escape.
2. Trap guards by Proset or prior approved equal.

2.6 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft. thickness.
2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 and 23 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Install air-admittance-valve wall boxes recessed in wall where indicated on drawings.

H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

I. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

J. Install deep-seal traps on all floor drains.

A. Install trap guards at floor drains that require trap-seal.
1. Size: Same as floor drain inlet.

B. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

C. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

D. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

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SECTION 221413 – FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following storm drainage piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

E. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:

1. Storm Drainage Piping: 30-foot head of water.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
2. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.

C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

    a. Available Manufacturers:

        1) ANACO.
        2) Fernco, Inc.
        3) Ideal Div.; Stant Corp.
        4) Mission Rubber Co.
        5) Tyler Pipe; Soil Pipe Div.
        6) Or equal.

2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

    a. Manufacturers:

        1) ANACO.
        2) Clamp-All Corp.
        3) Ideal Div.; Stant Corp.
        4) Mission Rubber Co.
        5) Tyler Pipe; Soil Pipe Div.
        6) Or equal.

3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.

    a. Manufacturers:

        1) MG Piping Products Co.
        2) Or equal.

C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

    a. ANACO.
        1) Or equal.

2.5 ABS PIPE AND FITTINGS

A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.

B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

2.6 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

2.7 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Dallas Specialty & Mfg. Co.
b. Fernco, Inc.
c. Logan Clay Products Company (The).
d. Mission Rubber Co.
e. NDS, Inc.
f. Plastic Oddities, Inc.
g. Or equal.

2. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Mission Rubber Co.
c. Or equal.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

    a. ANACO.
    b. Or equal.

D. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.

1. Manufacturers:

    a. EBAA Iron Sales, Inc.
    b. Or equal.

E. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

    a. EBAA Iron Sales, Inc.
    b. Romac Industries, Inc.
    c. Star Pipe Products; Star Fittings Div.
    d. Or equal.

F. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

    a. SIGMA Corp.
    b. Or equal.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Plastic piping shall not be allowed in ceiling return plenums. Where piping is exposed to ceiling plenums, cast iron shall be used.

C. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; standard, and heavy-duty shielded, stainless-steel couplings; and coupled joints.

D. Below grade storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; standard, and heavy-duty shielded, stainless-steel couplings; and coupled joints.
3. PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 2 Section "Storm Drainage."

B. Basic piping installation requirements are specified in Division 22 and 23 Section "Common Work Results."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Plumbing Specialties."

E. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

F. Install underground, steel, force-main piping.[Install encasement on piping according to ASTM A 674 or AWWA C105.]

G. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 and 23 Section "Common Work Results."

H. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

M. Install engineered controlled-flow storm drainage piping in locations indicated.

N. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

O. Install ABS storm drainage piping according to ASTM D 2661.

P. Install PVC storm drainage piping according to ASTM D 2665.

Q. Install underground ABS and PVC storm drainage piping according to ASTM D 2321.

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods."

B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 and 23 Section "Valves."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Install gate or full-port ball valve for piping NPS 2 and smaller.
2. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Backwater valve are specified in Division 22 Section "Plumbing Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 and 23 Section "Mechanical Vibration Controls and Seismic Restraints."

B. Pipe hangers and supports are specified in Division 22 and 23 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 and 23 Section "Hangers and Supports."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

I. Install supports for vertical ABS and PVC piping every 48 inches.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Connect force-main piping to the following:

1. Storm Sewer: To exterior force main or storm manhole.
2. Sump Pumps: To sump pump discharge.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 20-foot head of water. From 4 hours before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221413

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following storm drainage piping specialties:

1. Cleanouts.
2. Through-penetration firestop assemblies.
3. Roof drains.
4. Miscellaneous storm drainage piping specialties.
5. Flashing materials.

B. Related Sections include the following:

1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PUR: Polyurethane plastic.

H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation.
    g. Prior approved equal.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Josam Div.
    b. Oatey.
    c. Sioux Chief Manufacturing Company, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Tyler Pipe; Wade Div.
    f. Watts Drainage Products Inc.

g. Zurn Plumbing Products Group; Light Commercial Operation.
h. Mifab.
i. Prior approved equal.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Threaded.
8. Closure: Cast-iron plug.
9. Adjustable Housing Material: Cast iron with.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Prior approved equal.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

D. Plastic Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Canplas LLC.
b. IPS Corporation.
c. NDS Inc.

d. Plastic Oddities; a division of Diverse Corporate Technologies.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Plumbing Products Group; Light Commercial Operation.
g. Prior approved equal.

2. Size: Same as connected branch.
3. Body: PVC.
4. Closure Plug: PVC.
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.2 ROOF DRAINS

A. Metal Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.
b. Marathon Roofing Products.
c. MIFAB, Inc.
d. Portals Plus, Inc.
e. Prier Products, Inc.
f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products Inc.
i. Zurn Plumbing Products Group; Light Commercial Operation.
j. Zurn Plumbing Products Group; Specification Drainage Operation.
k. Prior approved equal.

2. Standard: ASME A112.21.2M.
3. Pattern: Roof drain.
4. Body Material: Cast iron.
5. Dimensions of Body: See drawings.
6. Combination Flashing Ring and Gravel Stop: Required.
7. Outlet: Coordinate with drawings.
8. Dome Material: Cast iron.
9. Extension Collars: Required.
10. Underdeck Clamp: Required.
11. Sump Receiver: Required.

2.3 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout.
3. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
4. Size: Same as or larger than connected downspout.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

D. Downspout Nozzle:

1. All nickel bronze body with decorative face of wall flange and outlet nozzle.
2. Approved Types -

a. Zurn Z-199 or equal by
b. Wade
c. Smith
d. Josam

2.4 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 7.

1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

G. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

H. Install manufactured, gray-iron downspout boots at grade with top 18 inches above grade. Secure to building wall.

I. Install cast-iron soil pipe downspout boots at grade with top of hub 18 inches above grade.

J. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

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SECTION 223400 - FUEL-FIRED WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following fuel-fired water heaters:

1. Commercial, high-efficiency, gas water heaters.
2. Compression tanks.
3. Water heater accessories.

1.3 DEFINITIONS

A. LP Gas: Liquefied-petroleum fuel gas.

1.4 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: For each type of commercial water heater, signed by product manufacturer.

D. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. 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. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For water heaters to include in operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including storage tank and supports.
    b. Faulty operation of controls.
    c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period(s): From date of Substantial Completion:

    a. Household, Gas Water Heaters:

        1) Storage Tank: Five years.
        2) Controls and Other Components: Two years.

    b. Commercial, Gas Water Heaters:

        1) Storage Tank: Three years.
        2) Controls and Other Components: Three years.

    c. Compression Tanks: One year(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL, GAS WATER HEATERS

A. Commercial, High-Efficiency, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.

1. Manufacturers:

    a. AERCO International.
    b. Bradford White Corporation.
    c. Lochinvar Corporation.
    d. Patterson-Kelley.
    e. Raypak
    f. RBI Water Heaters; a Mestek, Inc. Company.
    g. Rheem Water Heater Div.; Rheem Manufacturing Company.
    h. Ruud Water Heater Div.; Rheem Manufacturing Company.
    i. Smith, A. O. Water Products Company.

j. HTP
k. Bock
l. Prior approved equal.

2. Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions. Following features and attributes may be modified or omitted if water heater otherwise complies with requirements for performance.
3. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.

    a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

        1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
        2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

    b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Lining: Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

4. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
    d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
    e. Jacket: Steel with enameled finish.
    f. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

5. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for high-efficiency water heaters and for natural-gas fuel.
6. Temperature Control: Adjustable thermostat.
7. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
8. Energy Management System Interface: Normally closed dry contacts for enabling and disabling water heater.
9. Draft Hood: Draft diverter; complying with ANSI Z21.12.
10. Capacity and Characteristics: See Drawings

2.3 COMPRESSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

1. Available Manufacturers:

a. AMTROL Inc.
b. Armstrong Pumps, Inc.
c. Flexcon Industries.
d. Honeywell Sparco.
e. Smith, A. O.; Aqua-Air Div.
f. State Industries, Inc.
g. Taco, Inc.
h. Watts Regulator Co.
i. Wessels Co.
j. Prior approved equal.

2. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics: See Drawings

2.4 WATER HEATER ACCESSORIES

A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.

B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.

C. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.

D. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.

1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.

E. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.

1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.

F. Water Heater Stand and Drain Pan Units: High-density-polyethylene-plastic, 18-inch-high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 drain outlet with ASME B1.20.1 pipe thread.

G. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Provide dimension that will support bottom of water heater a minimum of 18 inches above the floor.

H. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

I. Drain Pans: Corrosion-resistant metal with raised edge. Provide dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

J. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that is capable of isolating each water heater and of providing balanced flow through each water heater.

K. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.

1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
2. Concrete base construction requirements are specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods."

B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Install seismic restraints for commercial water heaters. Anchor to substrate.

D. Install gas water heaters according to NFPA 54.

E. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.

F. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

G. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.

H. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

I. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

J. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 and 23 Section "Plumbing Specialties" for hose-end drain valves.

K. Install thermometer on outlet piping of water heaters. Refer to Division 22 and 23 Section "Meters and Gages" for thermometers.

L. Install pressure gage(s) on inlet and outlet piping of commercial, fuel-fired water heater piping. Refer to Division 22 and 23 Section "Meters and Gages" for pressure gages.

M. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 and 23 Section "Valves" for general-duty valves and to Division 22 and 23 Section "Meters and Gages" for thermometers.

N. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

O. Fill water heaters with water.

P. Charge compression tanks with air.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters. Refer to Division 1 Section "Closeout Procedures Demonstration and Training."

END OF SECTION 223400

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SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:

1. Lavatories.
2. Lavatory Faucets.
3. Water closets.
4. Toilet seats.
5. Flushometers - Water Closets.
6. Urinals.
7. Flushometers - Urinals.
8. Fixture supports.
9. Protective shielding guards.
10. Commercial sinks.
11. Sink Faucets.
12. Service sinks.

B. Related Sections include the following:

1. Division 22 Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads

and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Operation and Maintenance Data: For plumbing fixtures to include in operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
4. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
5. Vitreous-China Fixtures: ASME A112.19.2M.
6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
7. Water-Closet, Flushometer Tank Trim: ASSE 1037.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.
12. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Manual-Operation Flushometers: ASSE 1037.
4. Plastic Tubular Fittings: ASTM F 409.
5. Brass Waste Fittings: ASME A112.18.2.
6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Flexible Water Connectors: ASME A112.18.6.
3. Floor Drains: ASME A112.6.3.
4. Grab Bars: ASTM F 446.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Hot-Water Dispensers: ASSE 1023 and UL 499.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Toilet Seats: ANSI Z124.5.
10. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of unit shell.
b. Faulty operation of controls, blowers, pumps, heaters, and timers.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: One year from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 2 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.

PART 2 - PRODUCTS

2.1 LAVATORIES

A. Lavatories:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.
b. Commercial Enameling Company.
c. Eljer.
d. Kohler Co.
e. Crane.
f. Sloan
g. Zurn.

2. Description: Accessible, wall-mounting, vitreous-china fixture.

a. Type: With back.
b. Size: 20 by 18 inches rectangular.
c. Faucet Hole Punching: Three holes, 4-inch centers.
d. Color: White.
e. Supplies: NPS 3/8 chrome-plated copper with stops.
f. Drain: Grid with offset waste.

1) Location: Near back of bowl.

B. Lavatories, Under Counter Mounted:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Commercial Enameling Company.
b. Eljer.
c. Kohler Co.
d. American Standard.
e. Crane.
f. Sloan
g. Zurn.
h. Prior approved equal.

2. Description: Accessible Counter-mounting, vitreous-china fixture.

a. Type: Undermount
b. Lavatory Size: see drawings
c. Faucet Hole Punching: Three holes, 4-inch centers.
d. Color: White.
e. Supplies: NPS 3/8 chrome-plated copper with stops.
f. Drain: Grid with offset waste.

1) Location: Near back of bowl.

C. Mixing valve:

1. Valve shall be thermostatic and pressure mixing valve with maximum 5 degree approach temperature.
2. Approved Manufacturers -

a. Powers hydroguard TP or equal by
b. Sloan
c. Prior approved equal

2.2 LAVATORY FAUCETS

A. Lavatory Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Eljer.
f. Elkay Manufacturing Co.
g. Fisher Manufacturing Co.
h. Just Manufacturing Company.
i. Kohler Co.
j. Moen, Inc.
k. Royal Brass Mfg. Co.
l. Sayco; a Briggs Plumbing Products, Inc. Company.
m. Speakman Company.
n. Sloan
o. T & S Brass and Bronze Works, Inc.
p. Zurn Plumbing Products Group; Commercial Brass Operation.
q. Prior approved equal.

2. Description: Sensor operated, hardwired, provide with low voltage transformer. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.
b. Finish: Satin finish or stainless steel
c. Maximum Flow Rate: 0.5 gpm.
d. Centers: 4 inches.
e. Mounting: Deck, concealed.
f. Spout: Rigid type.
g. Spout Outlet: Aerator.
h. Drain: Grid.
i. Tempering Device: Thermostatic.

2.3 WATER CLOSETS

A. Water Closets, Floor mounted-flushvalve:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc. 3043.001 (ADA), 2234.001 (standard) or equal by

1) Briggs Plumbing Products, Inc.
2) Crane Plumbing, L.L.C./Fiat Products.
3) Eljer.
4) Kohler Co.
5) TOTO USA, Inc.
6) Sloan
7) Zurn.

2. Description: Accessible where indicated on drawings, Floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.

    1) Bowl Type: Elongated front with siphon-jet design. Include bolt caps matching fixture.
    2) Height: Accessible where indicated on drawings.
    3) Design Consumption: 1.6 gal./flush.
    4) Color: White.

2.4 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Comfort seats C108SSCAM or equal.
    b. American Standard Companies, Inc.
    c. Bemis Manufacturing Company.
    d. Church Seats.
    e. Eljer.
    f. Kohler Co.
    g. Olsonite Corp.

2. Description: Toilet seat for water-closet-type fixture.

    a. Material: Molded, heavy duty, solid, anti-microbial plastic.
    b. Configuration: Open front without cover.
    c. Hinge Type: Stainless Steel, self-sustaining.
    d. Class: Standard commercial.
    e. Color: White.

2.5 FLUSHOMETERS-WATER CLOSETS

A. Flushometers, Water Closets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Coyne & Delany Co.
    b. Sloan Valve Company.
    c. Zurn Plumbing Products Group.
    d. Prior approved equal

2. Description: Flushometer for water closet fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

    a. Internal Design: Diaphragm operation.

b. Style: Exposed.
c. Inlet Size: NPS 1".
d. Trip Mechanism: Sensor operated, hard wired. Provide with low voltage transformer.
e. Consumption: 1.6 gal./flush.

2.6 URINALS

A. Urinals:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.
b. Crane Plumbing, L.L.C./Fiat Products.
c. Eljer.
d. Kohler Co.
e. Sloan
f. TOTO USA, Inc.
g. Zurn.
h. Prior approved equal.

2. Description: Accessible, where indicated on drawings, Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.

a. Type: Blowout with extended shields.
b. Strainer or Trapway: Open trapway with integral trap.
c. Design Consumption: 1 gal./flush.
d. Color: White.
e. Supply Spud Size: NPS 3/4.
f. Outlet Size: NPS 1-1/2.

2.7 FLUSHOMETERS-URINALS

A. Flushometers, Urinals:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Coyne & Delany Co.
b. Sloan Valve Company.
c. Zurn Plumbing Products Group.
d. Prior approved equal

2. Description: Flushometer for urinal-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

a. Internal Design: Diaphragm operation.
b. Style: Exposed.

c. Inlet Size: NPS 3/4.
d. Trip Mechanism: Sensor operated, hard wired. Provide with low voltage transformer.
e. Consumption: 0.125 gal./flush.

2.8 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.
7. Prior approved equal.

B. Water-Closet Supports:

1. Description: Combination carrier designed for accessible or standard mounting height as required of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:

1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

E. Sink Supports:

1. Description: Type II, sink carrier with hanger plate, bearing studs, and tie rod for sink-type fixture. Include steel uprights with feet.

2.9 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. TRUEBRO, Inc.
    b. Plumberex.
    c. McGuire.
    d. Proflo.
    e. Prior approved equal.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.10 COMMERCIAL SINKS

A. Commercial Sinks, Single Compartment Break Room Sink:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Elkay Manufacturing Co.
    b. Just Manufacturing Company.
    c. Prior approved equal.

2. Description: One-compartment, counter-mounting, stainless-steel commercial sink with backsplash.

    a. Overall Dimensions: See drawings.
    b. Metal Thickness: 18 Gauge.
    c. Compartment:

        1) Drain: NPS 1-1/2 tailpiece with stopper.

            a) Location: Centered in compartment.

2.11 SINK FAUCETS

A. Sink Faucets One compartment :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Standard Companies, Inc.
    b. Bradley Corporation.
    c. Chicago Faucets.
    d. Delta Faucet Company.
    e. Eljer.
    f. Elkay Manufacturing Co.
    g. Fisher Manufacturing Co.
    h. Just Manufacturing Company.

i. Kohler Co.
j. Moen, Inc.
k. Sayco; a Briggs Plumbing Products, Inc. Company.
l. Speakman Company.
m. T & S Brass and Bronze Works, Inc.
n. Zurn Plumbing Products Group.

2. Description: Kitchen faucet without spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.
b. Finish: Satin or stainless steel
c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
d. Mixing Valve: Single control.
e. Mounting: Deck.
f. Handle(s): Lever.
g. Spout Type: Swing, solid brass.
h. Spout Outlet: Aerator.

Drain: basket strainer

2.12 SERVICE SINKS

A. Service Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard Companies, Inc.
b. Commercial Enameling Company.
c. Eljer.
d. Kohler Co.

2. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.

a. Size: 28 by 28 inches.
b. Color: White.
c. Faucet: Sink American Standard 8344.111 with threaded spout and48 inch hose and damp or equal by

1) Eljer.
2) Kohler.
3) Speakman.

d. Drain: Grid with NPS 2 outlet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 and 23 Section "Valves."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods."

U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust all fixtures. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

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SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following water coolers and related components:
   1. Pressure water coolers.
   2. Fixture supports.

1.3 DEFINITIONS

A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

F. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fixtures to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filter Cartridges: Equal to 100 percent of amount installed for each type and size indicated, but no fewer than 1 of each.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Water Coolers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elkay Manufacturing Co. model EZSTL8C or equal by
b. Acorn Aqua.
c. Haws Corporation.
d. Prior approved equal.

2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult and child-mounting height.

a. Cabinet: Bilevel with two attached cabinets and with bilevel skirt kit.
b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
c. Control: Push bar.
d. Supply: NPS 3/8 with ball, gate, or globe valve.
e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
g. Provide with auxiliary bottle filler, Elkay EZH20 or prior approved equal.
h. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

    1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
    2) Electrical Characteristics: 1/3 hp; 120-V ac; single phase; 60 Hz.

i. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

2.2 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.
7. Prior approved equal.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
1. Type II: Bilevel, hanger-type carrier with three vertical uprights.
2. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set freestanding and pedestal drinking fountains on floor.

D. Set remote water coolers on floor, unless otherwise indicated.

E. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 and 23 Section "Valves."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods."

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 224700

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SECTION 230100 - GENERAL REQUIREMENTS FOR PLUMBING AND HVAC

PART 1 - GENERAL

1.1 GENERAL

A. General Conditions and Division 01 apply to this Division.

B. See Section 220100, "General Requirements for Plumbing and HVAC."

1.2 SCOPE

A. All requirements and information contained in Division 22 Section 220100, "General Requirements for Plumbing and HVAC" shall apply to both Divisions 22 and 23.

1.3 SITE OBSERVATION

A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS

A. See Section 220100, "General Requirements for Plumbing and HVAC."

1.5 COORDINATION OF WORK:

A. See Section 220100, "General Requirements for Plumbing and HVAC."

1.6 EQUIPMENT & MATERIALS:

A. See Section 220100, "General Requirements for Plumbing and HVAC."

1.7 PROJECT SUBMITTALS:

A. See Section 220100, "General Requirements for Plumbing and HVAC."

1.8 WARRANTY GUARANTEE:

A. See Section 220100, "General Requirements for Plumbing and HVAC."

B. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications as represented by manufacturer's published data.

C. The Contractor shall guarantee that the installation and operation of the equipment shall be free from defects for a period of one year beginning at date of substantial completion and acceptance. The Contractor shall replace or repair any part of the installation that is found to be defective or incomplete within the guarantee period.

D. The one year guarantee on equipment and systems shall commence when equipment has been demonstrated to work and has been accepted. (Example: If an equipment item fails to perform and it takes 9 months after substantial completion to correct, then the guarantee shall commence after the item has been demonstrated to perform and has been accepted.)

E. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.9 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. See Section 220100, "General Requirements for Plumbing and HVAC."

.

PART 2 - PRODUCTS
(Not Used)

PART 3 - EXECUTION
(Not Used)

END OF SECTION 230100

SECTION 230500 - BASIC PLUMBING AND HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Division 22, Section 220500, "Basic Plumbing and HVAC Materials and Methods."

1.2 SUMMARY

A. All requirements in Division 22, Section 220500, "Basic Plumbing and HVAC Materials and Methods" shall apply to both Divisions 22 and 23.

1. Equipment installation requirements common to equipment sections.

PART 2 - PRODUCTS

2.1 See Division 22, Section 220500, "Basic Plumbing and HVAC Materials and Methods."

PART 3 - EXECUTION

3.1 See Division 22, Section 220500, "Basic Plumbing and HVAC Materials and Methods"

END OF SECTION 230500

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with

indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

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SECTION 230519 - METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 22 "Meters and Gauges.

1.2 SUMMARY

1. Section 22 "Meters and Gauges" shall apply to divisions 22 and 23.

PART 2 - PRODUCTS

2.1 Section 22 "Meters and Gauges."

PART 3 - EXECUTION

3.1 Section 22 "Meters and Gauges."

END OF SECTION 230519

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SECTION 230523 – GENERAL DUTY VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 220523 Valves

1.2 SUMMARY

A. Section 220523 "Valves" shall apply to both Divisions 22 and 23.

PART 2 - PRODUCTS

2.1 SEE SECTION 220523 "Valves"

PART 3 - EXECUTION

3.1 SEE SECTION 220523 "Valves"

END OF SECTION 230523

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SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section 22 "Hangers and Supports for Plumbing" shall apply to both divisions 22 and 23.

PART 2 - PRODUCTS

2.1 SEE SECTION "Hangers and supports for plumbing"

PART 3 - EXECUTION

3.1 SEE SECTION "Hangers and supports for plumbing"

END OF SECTION 230529

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SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC AND PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 220548 "Vibration and Seismic Controls for HVAC and Plumbing Piping and Equipment" shall apply to both divisions 22 and 23.

1.2 SUBMITTALS

A. See section 220548:

PART 2 - PRODUCTS

2.1 See section 220548 "Vibration and Seismic Controls for HVAC and Plumbing Piping and Equipment"

PART 3 - EXECUTION

3.1 See section 220548 "Vibration and Seismic Controls for HVAC and Plumbing Piping and Equipment"

END OF SECTION 230548

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SECTION 230553 – IDENTIFICATION FOR MECHANICAL AND PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 22 "Identification for Mechanical and Plumbing Piping and Equipment"

SUMMARY

C. Section 22 ""Identification for Mechanical and Plumbing Piping and Equipment" shall apply to both divisions 22 and 23.

PART 2 - PRODUCTS

SEE SECTION 22 "Identification for Mechanical and Plumbing Piping and Equipment"

PART 3 - EXECUTION

SEE SECTION 22 "Identification for Mechanical and Plumbing Piping and Equipment"

END OF SECTION 230553

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:

    a. Constant-volume air systems.
    b. Variable-air-volume systems.

2. Hydronic Piping Systems:

    a. Constant-flow systems.
    b. Variable-flow systems.
    c. Primary-secondary systems.

3. HVAC equipment quantitative-performance settings.
4. Existing systems TAB.
5. Verifying that automatic control devices are functioning properly.
6. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

a. Submittal distribution requirements.
b. The Contract Documents examination report.
c. TAB plan.
d. Work schedule and Project-site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. Approved TAB agencies:

1. Bonneville Test and Balance.
2. BCS
3. BTC Services.
4. Certified Test and Balance.
5. Diamond Test and Balance
6. Elephant Test and Balance
7. Environmental Systems Balancing
8. Intermountain Test and Balance.

9. RS Analysis.
10. Tempco
11. Prior approved equal

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS
(Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit

manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Refrigerant Coils: Measure the following data for each coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow

and water flow rates. If 5 percent or less, equipment adjustments are not required.

4. Air balance each air outlet.

3.16 PROCEDURES FOR TESTING DUCT SYSTEMS

A. Perform duct leakage tests and duct cleanliness tests.

B. Duct system will be considered defective if it does not pass initial tests and inspections. The sheet metal contractor shall be responsible to make corrections and repairs as necessary to pass the tests. TAB contractor shall include initial test and 1 follow up test. Any additional follow up tests required due to system not passing shall be performed by the TAB contractor at the Division 22 and 23 contractor's expense.

3.17 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.18 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.19 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.20 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Provide final report on standard AABC or NEBB forms.

3.21 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Measure sound levels at two locations.
e. Measure space pressure of at least 10 percent of locations.
f. Verify that balancing devices are marked with final balance position.

g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.22 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

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SECTION 230700 - HVAC AND PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. See section 220700 for HVAC and plumbing insulation.

1.2 SUMMARY

A. Section 220700 HVAC and Plumbing insulation shall apply to insulation requirements for both division 22 and 23.

B. Division 23 Section 233113 "Metal Ducts" for duct liners.

1.3 SUBMITTALS

A. See section 220700.

PART 2 - PRODUCTS

2.1 See section 220700.

PART 3 - EXECUTION

3.1 See section 220700

END OF SECTION 230700

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SECTION 230800 - COMMISSIONING OF HVAC

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 Cx process requirements for the following HVAC systems, assemblies, and equipment:

1. Energy supply systems.
2. Heat generation systems.
3. Cooling generation systems.
4. Central-station air-handling systems.
5. Air, steam, and hydronic distribution systems.
6. Heating and cooling terminal and unitary equipment.
7. HVAC controls.
8. TAB verification.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

D. IGCC: International Green Construction Code.

E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.

F. TAB: Testing, adjusting, and balancing.

1.4 INFORMATIONAL SUBMITTALS

A. Construction Checklists:

1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Div. 23 Subcontractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.

B. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Div. 23 Subcontractor, provide the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

    a. Instrument or tool identification number.
    b. Equipment schedule designation of equipment for which the instrument or tool is required.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians performing BAS Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations are to have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA)-Certified Control Systems Technician (CCST) Level I.

B. HVAC Testing Technician Qualifications: Technicians to perform HVAC Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level; vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
2. Minimum three years' experience that is to include installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

    a. Be calibrated by manufacturer with current calibration tags permanently affixed.
    b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

2. HVAC proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Cx PROCESS:

A. Perform Cx process in accordance with Section 019113 "General Commissioning Requirements" for BAS and HVAC and in accordance with the following:

1. ASHRAE 202.
2. DFCM High Performance Building Standard
3. Commissioning standards acceptable to the authority having jurisdiction.

3.2 Cx TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.3 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

3.4 Cx TESTS COMMON TO HVAC SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response in accordance with acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 23 Sections specifying HVAC systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.
2. Cx Construction Checklist verification test demonstrations.

3.5 TAB VERIFICATION

A. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

B. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

C. Scope: HVAC air systems and hydronic piping systems.

D. Purpose: Differential flow relationships intended to maintain air and water pressurization differentials between the various areas of Project.

E. Conditions of the Test:

1. Cx Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Systems operating in full heating mode with minimum outside-air volume.
3. Systems operating in full cooling mode with minimum outside-air volume.
4. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

F. Acceptance Criteria:

1. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than the tolerances allowed.
3. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

END OF SECTION 230800

DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 230900 - BUILDING MANAGEMENT SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Building Management System (BMS), utilizing direct digital controls.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Products Supplied But Not Installed Under This Section:
1. Control valves.
2. Flow switches.
3. Wells, sockets and other inline hardware for water sensors (temperature, pressure, flow).
4. Automatic control dampers, where not supplied with equipment.
5. Terminal unit controllers and actuators, when installed by terminal unit manufacturer.

B. Products Installed But Not Supplied Under This Section:
1. None.

C. Products Not Furnished or Installed But Integrated with the Work of This Section:
1. In-line meters (gas, water, power).
2. Chemical water treatment.
3. Smoke detectors (through alarm relay contacts).

D. Work Required Under Other Divisions Related to This Section:
1. Power wiring to line side of motor starters, disconnects or variable frequency drives.
2. Provision and wiring of smoke detectors and other devices relating to fire alarm system.
3. Campus LAN (Ethernet) connection adjacent to JACE network management controller.

1.3 RELATED SECTIONS

A. Section 23 05 00 - Basic Mechanical Materials and Methods: Performance and reference standards for products and materials required for the Project.

1.4 SYSTEM DESCRIPTION

A. Provide a new or Building Automation System (BAS) to integrate and control all mechanical equipment associated with the mechanical system.
1. The Building Automation System shall be as indicated on the drawings and described in these specifications. System must be fully integrated and coordinated with mechanical equipment DDC controllers furnished and

installed in the equipment manufacturer's factory as specified in those sections. The intent of the BAS is to integrate all mechanical equipment into one system for monitoring, control, and alarming associated with the building. It is the BAS manufacturer's responsibility to provide all the design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BAS operators have the capability of managing the building mechanical system to ensure occupant comfort while maintaining energy efficiency.

2. The controls system provider for this project, shall be Niagara 4 certified and responsible for the control work described herein. Including material, labor, hardware, software, warranty, etc. including cost of system, design, programming, software setup and installation including wire and conduit, checkout, test and demonstration.
3. The BAS shall meet open standard protocol communication standards (As defined in System Communications Section) to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BAS manufacturers in future projects.
4. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems and terminal devices on this project.
5. The BAS shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by the security permissions of the operator role. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.
6. BAS shall communicate over BACNET-IP.

1.5 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:
1. Actuator: Control device that opens or closes valve or damper in response to control signal.
2. AI: Analog Input.
3. AO: Analog Output.
4. Analog: Continuously variable state over stated range of values.
5. BMS: Building Management System.
6. DDC: Direct Digital Control.
7. Discrete: Binary or digital state.
8. DI: Discrete Input.
9. DO: Discrete Output.
10. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
11. FO: Fail open (position of control device or actuator). Device moves to open position on loss of control signal or energy source.
12. GUI: Graphical User Interface.
13. HVAC: Heating, Ventilating and Air Conditioning.
14. IDC: Interoperable Digital Controller.
15. ILC: Interoperable Lon Controller.
16. LAN: Local Area Network.
17. Modulating: Movement of a control device through an entire range of values, proportional to an infinitely variable input value.

18. Motorized: Control device with actuator.
19. NAC: Network Area Controller.
20. NC: Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
21. NO: Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.
22. OSS: Operating System Server, host for system graphics, alarms, trends, etc.
23. Operator: Same as actuator.
24. PC: Personal Computer.
25. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
26. P: Proportional control; control mode with continuous linear relationship between observed input signal and final controlled output element.
27. PI: Proportional-Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controller variable (reset control).
28. PICS: BACnet Product Interoperability Compliance Statement.
29. PID: Proportional-Integral-Derivative control, control mode with continuous correction of final controller output element versus input signal based on proportional error, its time history (reset) and rate at which it's changing (derivative).
30. Point: Analog or discrete instrument with addressable database value.
31. WAN: Wide Area Network.

1.6 SUBMITTALS

A. Submit under the provisions of Section 01 30 00.

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. Installation methods.

C. Submit documentation of contractor qualifications, including those indicated in "Quality Assurance" if requested by the A-E.

D. Electronic copies of shop drawings of the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers' catalog data sheets and installation instructions. Submit in printed electronic format. Samples of written Controller Checkout Sheets and Performance Verification Procedures for applications similar in scope shall be included for approval.

E. Shop drawings shall also contain complete wiring and schematic diagrams, sequences of operation, control system bus layout and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings.

F. Provide Graphics Submittals within 8 weeks of control submittals. No more than 50% of controls may be billed for until graphics submittals are approved.

G. Upon completion of the work, provide 2 complete sets of ' as-built' drawings and other project-specific documentation in 3-ring hard-backed binders and on Flash media.

H. Any deviations from these specifications or the work indicated on the drawings shall be clearly identified in the Submittals.

1.7 QUALITY ASSURANCE

A. The Control System Contractor shall have a full service DDC office within 50 miles of the job site. This office shall be staffed with applications engineers, software engineers and field technicians. This office shall maintain parts inventory and shall have all testing and diagnostic equipment necessary to support this work, as well as staff trained in the use of this equipment.

B. Single Source Responsibility of Supplier: The Control System Contractor shall be responsible for the complete installation and proper operation of the control system. The Control System Contractor shall exclusively be in the regular and customary business of design, installation and service of computerized building management systems similar in size and complexity to the system specified. The Control System Contractor shall be the manufacturer of the primary DDC system components or shall have been the authorized representative for the primary DDC components manufacturer for at least 5 years. All control panels shall be assembled by the Control System Contractor in a UL-Certified 508A panel shop.

C. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in the production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work of this section.

1.9 DELIVERY, STORAGE AND HANDLING

A. Maintain integrity of shipping cartons for each piece of equipment and control device through shipping, storage and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.10 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct

and conduit runs, electrical outlets and fixtures, air diffusers and structural and architectural features.

1.11 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following Building Automation System Manufactures are approved to provide controls systems: Niagara 4 Framework (Niagara Framework 4.12)

B. Scope: Furnish all labor, materials and equipment necessary for a complete and operating Building Management System (BMS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section shall communicate on a peer-to-peer bus over an open protocol bus (Examples: BACnet, MODBUS, and MS/TP). IP Based style communication Protocol will not be accepted.

1. The intent of this specification is to provide a system that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.

2. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, BACnet and MODBUS and MS/TP.

3. System architecture shall provide secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN. (Including, HTTP Client Driver, The HTTP Client module provides tools and a driver, which interact with HTTP services, such as web services and restful API endpoints).

4. All hardware and field-level devices installed shall not be limited in their ability to communicate with a specific brand of Niagara Framework JACE. They shall also be constructed in a modular fashion to permit the next generation and support components to be installed, in replacement of or in parallel with existing components.

5. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.

6. The contractor shall supply one or more JACEs Niagara 4 as part of this contract. Number of area controllers required is dependent on the type and quantity of

devices provided. Provide Niagara controllers with add on I/O modules to provide auxiliary monitoring and control functions of major systems (Examples: Chilled Water Systems, Hot Water Systems, AHU Systems, and the like).

7. Any control vendor that shall provide additional BMS server software shall be unacceptable. Only systems that utilize the Niagara 4 Framework shall satisfy the requirements of this section.
8. The BMS server shall host all graphic files for the control system. All graphics and navigation schemes for this project shall match those that are on the existing campus NiagaraAX or Niagara 4 Framework server.
9. A laptop computer including engineering/programming software to modify Operating System Server BMS programs and graphics shall be included.
10. Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.
11. OPEN NIC STATEMENTS - All Niagara 4 software licenses shall have the following NiCS: "accept.station.in=*"; "accept.station.out=*"and "accept.wb.in=*"and "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications. This includes all JACE-8000 Controllers and Supervisor Software, so that the system as a whole meets the OPEN NICS Requirement.
12. All JACE hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted “safe boot” technology.
13. To ensure quality, the JACE-8000 used on this project shall come through the Tridium Richmond, VA shipping facility. JACE hardware products not meeting this requirement will not be allowed.

2.2 APPROVED CONTROLS CONTRACTORS

A. Harris Controls

B. Atkinson Electronics

C. Requests for substitutions will be considered in accordance with the provisions of Section 0160 00.

2.3 GENERAL

A. The Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, a network area controller, graphics and programming and other control devices for a complete system as specified herein.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall BMS.

2.4 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone,

distributed control system utilizing Open protocols in one open, interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, such as chillers, shall be via Ethernet or IP.

C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D. The supplied system shall incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the Operating System Server located in the Facilities Office on the LAN. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
   1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
   2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.5 SYSTEM NETWORK CONTROLLER (SNC)

A. These controllers are designed to manage communications between the programmable equipment controllers (PEC), application specific controllers (ASC) and advanced unitary controllers (AUC) which are connected to its communications trunks, manage communications between itself and other system network controllers (SNC) and with any operator workstations (OWS) that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS.

B. The controllers shall be fully programmable to meet the unique requirements of the facility it shall control.

C. The controllers shall be capable of peer-to-peer communications with other SNC's and with any OWS connected to the BAS, whether the OWS is directly connected, connected via cellular modem or connected via the Internet.

D. The communication protocols utilized for peer-to-peer communications between SNC's will be Niagara 4 Fox, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between SNC's is not allowed.

E. The SNC shall employ a device count capacity license model that supports expansion capabilities.

F. The SNC shall be enabled to support and shall be licensed with the following Open protocol drivers (client and server) by default:
1. BACnet
2. MODBUS
3. SNMP
4. KNX

G. The SNC 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 controller data.
7. Network management functions for all SNC, PEC and ASC based devices.

H. The SNC shall provide the following hardware features as a minimum:
1. Two 10/100 Mbps Ethernet ports.
2. Two Isolated RS-485 ports with biasing switches.
3. 1 GB RAM
4. 4 GB Flash Total Storage / 2 GB User Storage
5. Wi-Fi (Client or WAP)
6. USB Flash Drive
7. High Speed Field Bus Expansion
8. -20-60°C Ambient Operating Temperature
9. Integrated 24 VAC/DC Global Power Supply
10. MicroSD Memory Card Employing Encrypted Safe Boot Technology

I. The SNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

J. The SNC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.

K. The SNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.
1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
    a. Alarm.
    b. Return to normal.
    c. To default.
2. Alarms shall be annunciated in any of the following manners as defined by the user:
    a. Screen message text.
    b. Email of complete alarm message to multiple recipients.
    c. Pagers via paging services that initiate a page on receipt of email message.

d. Graphics with flashing alarm object(s).

3. The following shall be recorded by the SNC for each alarm (at a minimum):
   a. Time and date.
   b. Equipment (air handler #, access way, etc.).
   c. Acknowledge time, date, and user who issued acknowledgement.

L. Programming software and all controller "Setup Wizards" shall be embedded into the SNC.

M. The SNC shall support the following security functions.
1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
2. Role-Based Access Control (RBAC) for managing user roles and permissions.
3. Require users to use strong credentials.
4. Data in Motion and Sensitive Data at Rest be encrypted.
5. LDAP and Kerberos integration of access management.

N. The SNC shall support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:
1. Metadata: Descriptive tags to define the structure of properties.
2. Tagging: Process to apply metadata to components
3. Tag Dictionary

O. The SNC shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers (PEC, AUC, AVAV, VFD…) shall have an associated template file for reuse on future project additions.

P. The SNC shall be provided with a 5 Year Software Maintenance license. Labor to implement not included.

2.6 PROGRAMMABLE EQUIPMENT CONTROLLER (PEC)

A. HVAC control shall be accomplished using or BACnet based devices. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

B. All PECs shall be application programmable and shall at all times maintain their certification. All control sequences within or programmed into the PEC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.

C. The PEC shall provide LED indication of communication and controller performance to the technician, without cover removal.

D. The PEC shall not require any external configuration tool or programming tool. All configuration and programming tasks shall be accomplished and accessible from within the Niagara 4 environment.

E. The following integral and remote Inputs/Outputs shall be supported per each PEC:

1. Eight integral dry contact digital inputs.
2. Any two digital inputs may be configured as pulse counters with a maximum pulse read rate of 15 Hz.
3. Eight integral analog inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC).
4. Six integral 4-20 ma analog outputs.
5. Eight integral 24 Vac Triac digital outputs, configurable as maintained or floating motor control outputs.
6. One integral 20 Vdc, 65-mA power supply for auxiliary devices.
7. If a 20 Vdc 65-mA power supply terminal is not integral to the PEC, provide at each PEC a separate, fully isolated, enclosed, current limited and regulated UL listed auxiliary power supply for power to auxiliary devices.

F. Each PEC shall have expansion ability to support additional I/O requirements through the use of remote input/output modules.

G. PEC Controllers shall support at minimum the following control techniques:
1. General-purpose control loops that can incorporate Demand Limit Control strategies, Set point reset, adaptive intelligent recovery, and time of day bypass.
2. General-purpose, non-linear control loops.
3. Start/stop Loops.
4. If/Then/Else logic loops.
5. Math Function loops (MIN, MAX, AVG, SUM, SUB, SQRT, MUL, DIV, ENTHALPY).

2.7 ADVANCED UNITARY CONTROLLER (AUC)

A. The advanced unitary controller (AUC) platform shall be designed specifically to control HVAC - ventilation, filtration, heating, cooling, humidification, and distribution. Equipment includes: constant volume air handlers, VAV air handlers, packaged RTU, heat pumps, unit vents, fan coils, natural convection units and radiant panels. The control shall use BACnet based devices. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

B. Minimum Requirements:
1. The controller shall be fully programmable with full functionality on any Niagara 4 brand platform.
   a. Support downloads to the controller from any brand of Niagara 4 platform.
   b. Support uploads from the controller to any brand of Niagara 4 platform.
   c. Support simulation/debug mode of the controller.
   d. Maintain native GUI.
   e. Native function-block programming software and all controller “Setup Wizards” shall be embedded within the Niagara 4 environment.
2. The controller shall be capable of either integrating with other devices or stand-alone operation.
3. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for network communications. Controller memory minimum requirements include:

a. FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
b. FLASH Memory settings retained for ten years.
c. RAM: 2 Kilobytes.

4. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
   a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
   b. Accuracy: ±1 minute per month at 77 degrees F (25 degrees C).
   c. Power Failure Backup: 24 hours at 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
5. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
6. The controller shall have an internal DC power supply to power external sensors.
   a. Power Output: 20 VDC ±10% at 75 mA.
7. The controller shall have a visual indication (LED) of the status of the devise:
   a. Controller operating normally.
   b. Controller in process of download.
   c. Controller in manual mode under control of software tool.
   d. Controller lost its configuration.
   e. No power to controller, low voltage, or controller damage.
   f. Processor and/or controller are not operating.
8. The minimum controller Environmental ratings.
   a. Operating Temperature Ambient Rating: -40 degrees to 150 degrees F (-40 degrees to 65.5 degrees C).
   b. Storage Temperature Ambient Rating: -40 degrees to 150 degrees F (-40 degrees to 65.5 degrees C).
   c. Relative Humidity: 5% to 95% non-condensing.
9. The controller shall have the additional approval requirements, listings, and approvals:
   a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
   b. CSA (LR95329-3) Listed.
   c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
   d. Meets Canadian standard C108.8 (radiated emissions).
   e. Conforms requirements European Consortium standard EN 61000-6-1; 2001 (EU Immunity).
   f. Conforms requirements European Consortium standard EN 61000-6-3; 2001 (EU Emission).
10. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
11. The controller shall have a mix of digital inputs (DI), digital Triac outputs (DO), analog outputs (AO), and universal inputs (UI).
    a. Analog outputs (AO) shall be capable of being configured as digital outputs (DO).
    b. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
    c. Input and Output wiring terminals shall be designated with color coded labels.

d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).

12. The controller shall provide "continuous" automated loop tuning with an Adaptive Integral Algorithm Control Loop.
13. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.
    a. Discharge air control and low limit.
    b. Pressure-dependent dual duct without flow mixing.
    c. Variable air volume with return flow tracking.
    d. Economizer with differential enthalpy.
    e. Minimum airflow coordinated with CO2.
    f. Unit ventilator cycle (1, 2, 3) 2-pipe.
    g. Unit ventilator cycle (1, 2, 3) 2-pipe with face/bypass.
    h. Unit ventilator cycle (1, 2, 3) 4-pipe.
    i. Unit ventilator cycle (1, 2, 3) 4-pipe with EOC valve.

2.8 ADVANCED VARIABLE AIR VOLUME CONTROLLER (AVAV)

A. The advanced VAV controller platform shall be designed specifically for room-level VAV control - pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO2, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, Series fan powered terminal unit, Parallel fan powered terminal unit, Supply and Exhaust air volume terminals and Constant volume dual-duct terminal unit. Control shall be accomplished using BACnet based devices The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

B. Minimum Requirements:
1. The controller shall be fully programmable with full functionality on any Niagara 4 brand platform.
    a. Support downloads to the controller from any brand of Niagara 4 platform.
    b. Support uploads from the controller to any brand of Niagara 4 platform.
    c. Support simulation/debug mode of the controller.
    d. Maintain native GUI.
    e. Native function-block programming embedded software and all controller “Setup Wizards” shall be embedded within the Niagara 4 environment.
2. The controller shall be capable of either integrating with other devices or stand-alone room-level control operation.
3. The controller shall have an internal velocity pressure sensor.
    a. Sensor Type: Microbridge air flow sensor with dual integral restrictors.
    b. Operating Range: 0 to 1.5 inch H2O (0 to 374 Pa).
    c. Accuracy: ±2% of full scale at 32 degrees to 122 degrees F (0 degrees to 50 degrees C); ±1% of full scale at null pressure.
4. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the

main HVAC application. The second processor for network communications.
   a. FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
   b. FLASH Memory settings retained for ten years.
   c. RAM: 2 Kilobytes.
5. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
   a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
   b. Accuracy: ±1 minute per month at 77 degrees F (25 degrees C).
   c. Power Failure Backup: 24 hours at 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
6. The controller shall have Significant Event Notification, Periodic Update capability and Failure Detect when network inputs fail to be detected within their configurable time frame.
7. The controller shall have an internal DC power supply to power external sensors.
   a. Power Output: 20 VDC ±10% at 75 mA.
8. The controller shall have a visual indication (LED) of the status of the devise:
   a. Controller operating normally.
   b. Controller in process of download.
   c. Controller in manual mode under control of software tool.
   d. Controller lost its configuration.
   e. No power to controller, low voltage, or controller damage.
   f. Processor and/or controller are not operating.
9. The minimum controller Environmental ratings:
   a. Operating Temperature Ambient Rating: 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
   b. Storage Temperature Ambient Rating: 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
   c. Relative Humidity: 5% to 95% non-condensing.
10. The controller shall have the additional approval requirements, listings, and approvals:
   a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
   b. CSA (LR95329-3) Listed.
   c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
   d. Meets Canadian standard C108.8 (radiated emissions).
   e. Conforms requirements European Consortium standard EN 61000-6-1; 2001 (EU Immunity).
   f. Conforms requirements European Consortium standard EN 61000-6-3; 2001 (EU Emission).
11. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
12. The controller shall provide an integrated actuator option.
   a. Actuator type: Series Floating.
   b. Rotation stroke: 95 degrees ±3 degrees for CW or CCW opening dampers.
   c. Torque rating: 44 lb-inch (5 Nm).
   d. Run time for 90 degrees rotation: 90 seconds at 60 Hz.
13. The controller shall have digital inputs (DI), digital Triac outputs (DO), three analog outputs (AO), and universal inputs (UI).

a. Analog outputs (AO) shall be capable of being configured as digital outputs (DO).
b. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
c. Input and Output wiring terminals shall be designated with color coded labels.

14. The controller shall provide "continuous" automated loop tuning with an Adaptive Integral Algorithm Control Loop.
15. The controller shall have a loop execution response time of 1 second.
16. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.
    a. VAV terminal unit.
    b. VAV terminal unit fan speed control.
    c. Series fan.
    d. Parallel fan.
    e. Regulated air volume (room pressurization/de-pressurization).
    f. CV dual-duct.
    g. Room CO2 control.
    h. Room Humidity.
    i. TOD occupancy sensor stand-by set points.

2.9 OTHER CONTROL SYSTEM HARDWARE

A. Motorized control dampers that will not be integral to the equipment shall be furnished by the Control System Contractor. Control damper frames shall be constructed of galvanized steel, formed into changes and welded or riveted. Dampers shall be galvanized, with nylon bearings. Blade edge seals shall be vinyl. Blade edge and tip seals shall be included for all dampers. Blades shall be 16-gauge minimum and 6 inches wide maximum and frame shall be of welded channel iron. Damper leakage shall not exceed 10 CFM per square foot, at 1.5 inches water gauge static pressure. Honeywell is basis of design.

B. Control damper actuators shall be furnished by the Control System Contractor. Two-position or proportional electric actuators shall be direct-mount type sized to provide a minimum of 5 in-lb torque per square foot of damper area. Damper actuators shall be spring return type. Operators shall be heavy-duty electronic type for positioning automatic dampers in response to a control signal. Motor shall be of sufficient size to operate damper positively and smoothly to obtain correct sequence as indicated. All applications requiring proportional operation shall utilize truly proportional electric actuators. Honeywell is basis of design.

C. Control Valves: Control valves shall be 2-way or 3-way pattern as shown and constructed for tight shutoff at the pump shut-off head or steam relief valve pressure. Control valves shall operate satisfactorily against system pressures and differentials. Two-position valves shall be ' line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (unless otherwise noted or scheduled on the drawings). Valves with sizes up to and including 2 inches (51 mm) shall be "screwed" configuration and 2-1/2 inches (63.5 mm) and larger valves shall be "flanged" configuration. All control valves, including terminal unit valves, less than 2 inches (51 mm) shall be globe valves. Electrically-actuated control valves shall

include spring return type actuators sized for tight shut-off against system pressures (as specified above) and, when specified, shall be furnished with integral switches for indication of valve position (open-closed). Pneumatic actuators for valves, when utilized, shall be sized for tight shut-off against system pressures (as specified above). Honeywell is basis of design.

D. Control Valve Actuators: Actuators for VAV terminal unit heating coils shall be "drive-open; drive-closed" type. All actuators shall have inherent current limiting motor protection. Valve actuators shall be 24-volt, electronic type, modulating or two-position as required for the correct operating sequence. Actuators on valves needing ' fail-safe' operation shall have spring return to Normal position. Modulating valves shall be positive positioning in response to the signal. All valve actuators shall be UL listed. Honeywell is basis of design.

E. All control valves 2-1/2 inches (63.5 mm) or larger shall have position indication. All hot water control valves shall be Normally-Open arrangement; all chilled water control valves shall be Normally-Closed arrangement. Honeywell is basis of design.

F. Wall Mount Room Temperature sensors: Each room temperature sensor shall provide temperature indication to the digital controller, provide the capability for a software-limited occupant set point adjustment (warmer-cooler slider bar or switch) and limited operation override capability. Room Temperature Sensors shall be 20,000-ohm thermistor type with a temperature range of -40 to 140 degrees F (-38 to 60 degrees C). The sensor shall be complete with a decorative cover and suitable for mounting over a standard electrical utility box. These devices shall have an accuracy of 0.5 degrees F (.024 degrees C) over the entire range. Honeywell is basis of design.

G. Duct-mounted and Outside Air Temperature Sensors: 20,000-ohm thermistor temperature sensors with an accuracy of ±; 0.2 degrees C. Outside air sensors shall include an integral sun shield. Duct-mounted sensors shall have an insertion measuring probe of a length appropriate for the duct size, with a temperature range of -40 to 160 degrees F(-38 to 71 degrees C) The sensor shall include a utility box and a gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 8 feet (2438 mm) long sensor element. These devices shall have accuracy of 0.5 degrees F (.024 degrees C) over the entire range. Honeywell is basis of design.

H. Provide outside air “weather station” with protected OSA and enthalpy sensor.

I. Humidity sensors shall be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 0 to 90% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). Operating range shall be 0 to 100% RH and 32 to 140 degrees F (0 to 60 degrees C). Sensors shall be selected for wall, duct or outdoor type installation as appropriate. Honeywell is basis of design.

J. Carbon Dioxide Sensors (CO2): Sensors shall utilize Non-dispersive infrared technology (N.D.I.R.), repeatable to plus or minus 20 PPM. Sensor range shall be 0 - 2000 PPM. Accuracy shall be plus or minus five percent (5%) or 75 PPM, whichever is greater. Response shall be less than one minute. Input voltage shall be 20 to 30 VAC or DC. Output shall be 0 - 10 VDC. Sensor shall be wall or duct mounted type, as appropriate for the application, housed in a high impact plastic enclosure.

Honeywell is basis of design.

K. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point. Honeywell is basis of design.

L. Differential Analog (duct) Static Pressure Transmitters Provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy shall be plus or minus 1% of full range; range shall be selected for the specific application. Provide zero and span adjustment capability. Device shall have integral static pickup tube. Honeywell is basis of design.

M. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches shall have adjustable set points and barbed pressure tips. Honeywell is basis of design.

N. Water Flow Switches: Provide a SPST type contact switch with bronze paddle blade, sized for the actual pipe size at the location. If installed outdoors, provide a NEMA-4 enclosure. Flow switch shall be UL listed.

O. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. All electrical devices within a control panel shall be factory wired. Control panel shall be assembled by the BMS in a UL-Certified 508A panel shop. A complete set of ' as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

P. Pipe and Duct Temperature sensing elements: 20,000-ohm thermistor temperature sensors with and accuracy of ±1% accuracy. Their range shall be -5 to 250 degrees F (-20 to 121 degrees C). Limited range sensors shall be acceptable provided they are capable of sensing the range expected for the point at the specified accuracy. Thermal wells with heat conductive gel shall be included. Honeywell is basis of design.

Q. Low Air Temperature Sensors: Provide SPST type switch, with 15 to 55 degrees F (-9 to 13 degrees C), range, vapor-charged temperature sensor. Honeywell model L482A, or approved equivalent.

R. Variable Frequency Drives: The variable frequency drive (VFD) shall be designed specifically for use in Heating, Ventilation, and Air Conditioning (HVAC) applications in which speed control of the motor can be applied. The VFD, including all factory installed options, shall have UL & CSA approval. VFD's shall include communications capability with DDC BMS via built-in interface card (MODBUS or BACnet). Honeywell SmartVFD is basis of design.

S. Relays: Start/stop relay model shall provide either momentary or maintained switching action as appropriate for the motor being started. All relays shall be plugged in, interchangeable, mounted on a sub base and wired to numbered terminals strips. Relays installed in panels shall all be DPDT with indicating lamp. Relays installed outside of controlled devices shall be enclosed in a NEMA enclosure suitable for the location. Relays shall be labeled with UR symbol. RIB-style relays are acceptable for remote enable/disable.

T. Emergency Stop Switches: Provide toggle-type switch with normally-closed contact. Switch shall be labeled "AIR HANDLER EMERGENCY SHUTOFF, NORMAL - OFF.".

U. Transducers: Differential pressure transducers shall be electronic with a 4-20 mA output signal compatible to the Direct Digital Controller. Wetted parts shall be stainless steel. Unit shall be designed to operate in the pressure ranges involved.

V. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers shall be sized for the load, but shall be sized for 50 watts, minimum. Transformers shall be UL listed Class 2 type, for 120 VAC/24 VAC operation. Honeywell is basis of design.

W. Line voltage protection: All DDC system control panels that are powered by 120 VAC circuits shall be provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection shall meet UL, ULC 1449, IEEE C62.41B. A grounding conductor, (minimum 12 AWG), shall be brought to each control panel.

2.10 BAS SERVER & WEB BROWSER GUI - SYSTEM OVERVIEW

A. The BAS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.

B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Window operating systems.

C. The BAS server software shall support at least the following server platforms (Windows 7, 8.1, Server 12). The BAS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.

D. The web browser GUI shall provide a completely interactive user interface and shall provide a HTML5 experience that supports the following features as a minimum:
1. Trending.
2. Scheduling.
3. Electrical demand limiting.
4. Duty Cycling.
5. Downloading Memory to field devices.
6. Real time 'live' Graphic Programs.
7. Tree Navigation.
8. Parameter change of properties.
9. Set point adjustments.
10. Alarm / event information.
11. Configuration of operators.
12. Execution of global commands.
13. Add, delete, and modify graphics and displayed data.

E. Software Components: All software shall be the most current version. All software components of the BAS system software shall be provided and installed as part of this project. BAS software components shall include:
1. Server Software, Database and Web Browser Graphical User Interface.
2. 5 Year Software Maintenance license. Labor to implement not included.
3. Embedded System Configuration Utilities for future modifications to the system and controllers.
4. Embedded Graphical Programming Tools.
5. Embedded Direct Digital Control software.
6. Embedded Application Software.

F. BAS Server Database: The BAS server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BAS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.

G. Thin Client - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
1. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.
2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).

2.11 WEB BROWSER GRAPHICAL USER INTERFACE

A. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.

B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.

C. Navigation: Navigation through the GUI shall be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the

following views: Geographic, Network, Groups and Configuration.

1. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
2. Groups View shall display Scheduled Groups and custom reports.
3. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

D. Action Pane: The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:

1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.
2. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web browser. User shall have ability to save custom dashboards.
3. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
4. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
5. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
6. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
7. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
8. Logic - Live Graphic Programs: Shall be used to display' live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
9. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

E. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI workstation software shall graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones

throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.

4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability. .
5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
    a. Each piece of equipment monitored or controlled including each terminal unit.
    b. Each building.
    c. Each floor and zone controlled.

F. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

1. Schedules: Schedules shall comply with the BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
    a. Types of schedule shall be Normal, Holiday or Override.
    b. A specific date.
    c. A range of dates.
    d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
    e. Wildcard (example, allow combinations like second Tuesday of every month).
2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual

room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.

5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

G. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:

1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.
8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received

by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:

a. Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
d. Write Property: The write property reporting action updates a property value in a hardware module.
e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
f. Run External Program: The Run External Program reporting action launches specified program in response to an event.

H. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
7. Copy/Paste. The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).

I. Security Access: Systems that Security access from the web browser GUI to BAS server shall require a Login Name and Strong Password. Access to different areas of the BAS system shall be defined in terms of Role-Based Access Control privileges as specified:
   1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of ' easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
      a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
      b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
      c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.
   2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

2.12 GRAPHICAL PROGRAMMING

A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.

B. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

C. Graphic Sequence: The clarity of the graphic sequence shall be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.

D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:

1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose of selecting default parameter settings.
8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
10. Live Graphical Programs: The Graphic Programming software shall support a ' live' mode, where all input/output data, calculated data and set points shall be displayed in a ' live' real-time mode.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 GENERAL

A. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

B. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the Control System Contractor in accordance with these specifications.

C. Equipment furnished by the Mechanical Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the Control System Contractor.

D. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

3.4 WIRING

A. All electrical control wiring to the control panels shall be the responsibility of the Control System Contractor.

B. All wiring shall be in accordance with the Project Electrical Specifications (Division 16), the National Electrical Code and any applicable local codes. All control wiring shall be installed in raceways.

C. Excess wire shall not be looped or coiled in the controller cabinet.

D. Incorporate electrical noise suppression techniques in relay control circuits.

E. There shall be no drilling on the controller cabinet after the controls are mounted inside.

F. Careful stripping of wire while inside the cabinet is required to ensure that no wire strand fragments land on circuit boards.

G. Use manufacturer-specified wire for all network connections.

H. Use approved optical isolation and lightning protection when penetrating building envelope.

I. Read installation instructions carefully. Any unavoidable deviations shall be approved by owner's rep prior to installation.

3.5 ACCEPTANCE TESTING

A. Upon completion of the installation, the Control System Contractor shall load all system software and start-up the system. The Control System Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. The Control System Contractor shall perform tests to verify proper performance of components, routines and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output

points of the DDC system operation.

C. System Acceptance: Satisfactory completion is when the Control System Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 OPERATOR TRAINING

A. During system commissioning and at such time acceptable performance of the Control System hardware and software has been established, the Control System Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. The Control System Contractor shall provide 48 total hours of comprehensive training in multiple sessions for system orientation, product maintenance and troubleshooting, programming and engineering. These classes are to be spread out during the 1st year warranty period. The first class starting after final commissioning and the last class is to be in the last month of 1-year warranty period.

3.7 WARRANTY PERIOD SERVICES

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the BMS due to faulty materials, methods of installation or workmanship shall be promptly repaired or replaced by the Control System Contractor at no expense to the Owner.

C. Maintenance of Computer Software Programs: The Control System Contractor shall maintain all software during the standard first year warranty period. In addition, all factory or sub-vendor upgrades to software during the first year warranty period shall be added to the systems, when they become available, at no additional cost. In addition to first year standard warranty, software provided by Control System Contractor shall come with a 5 Year Software Maintenance license. All SNC and BAS Servers are included in this coverage. Labor to implement upgrades in years two through five are not included in standard warranty.

D. Maintenance of Control Hardware: The Control System Contractor shall inspect, repair, replace, adjust, and calibrate, as required, the controllers, control devices and associated peripheral units during the warranty period. The Control System Contractor shall then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work, and description of the corrective actions taken. The report shall clearly certify that all hardware is functioning correctly.

E. Service Period: Calls for service by the Owner shall be honored within 24 hours and are not to be considered as part of routine maintenance.

F. Service Documentation: A copy of the service report associated with each owner-initiated service call shall be provided to the owner.

3.8 WARRANTY ACCESS

A. The Owner shall grant to the Control System Contractor reasonable access to the BMS during the warranty period. Remote access to the BMS (for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period) will be allowed.

3.9 OPERATION & MAINTENANCE MANUALS

A. See Division 1 for requirements. O&M manuals shall include the following elements, as a minimum:
   1. As-built control drawings for all equipment.
   2. As-built Network Communications Diagram.
   3. General description and specifications for all components.
   4. Completed Performance Verification sheets.
   5. Completed Controller Checkout/Calibration Sheets.

3.10 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 230900

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DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 230993 - SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:
   1. Division 22 and 23 Section "HVAC Instrumentation and Controls" for control equipment and devices and for submittal requirements.

C. Graphics shall be coordinated with DFCM personnel.

1.03 DEFINITIONS

A. DDC: Direct digital control.

B. VAV: Variable air volume.

1.04 SPLIT SYSTEMS

A. Split systems shall be provided with a hard-wired factory thermostat, and operate under their own factory controls.

B. BAS shall provide a flat plate wall sensor for monitoring and alarming only. Coordinate alarm set points with DFCM, set initially for 75 deg F adj.

1.05 VAV ROOFTOP UNITS

A. VAV RTU shall be provided with factory controls package. Coordinate with manufacturer for control points available through hard contacts and through BACNET.

B. RTU shall have a dedicated occupancy schedule. When building is occupied, BAS shall enable the RTU to run continuously. When Occupied, RTU shall open outside air damper to minimum position for ventilation.

C. When building is unoccupied, BAS shall cycle the RTU to maintain unoccupied night set back temperatures.

D. BAS shall include Optimum Start Logic. BAS shall enable RTU to operate with OSA damper closed prior to building occupancy. BAS shall determine Optimum start based on how long it took the day before to get the building temperatures satisfied, plus 5 minutes (adj).

E. RTU shall control its economizer mode based on its own controls and outside air temperature.

F. BAS shall give the RTU a duct pressure reference and set point, and RTU shall modulate supply fan as needed to meet set point.

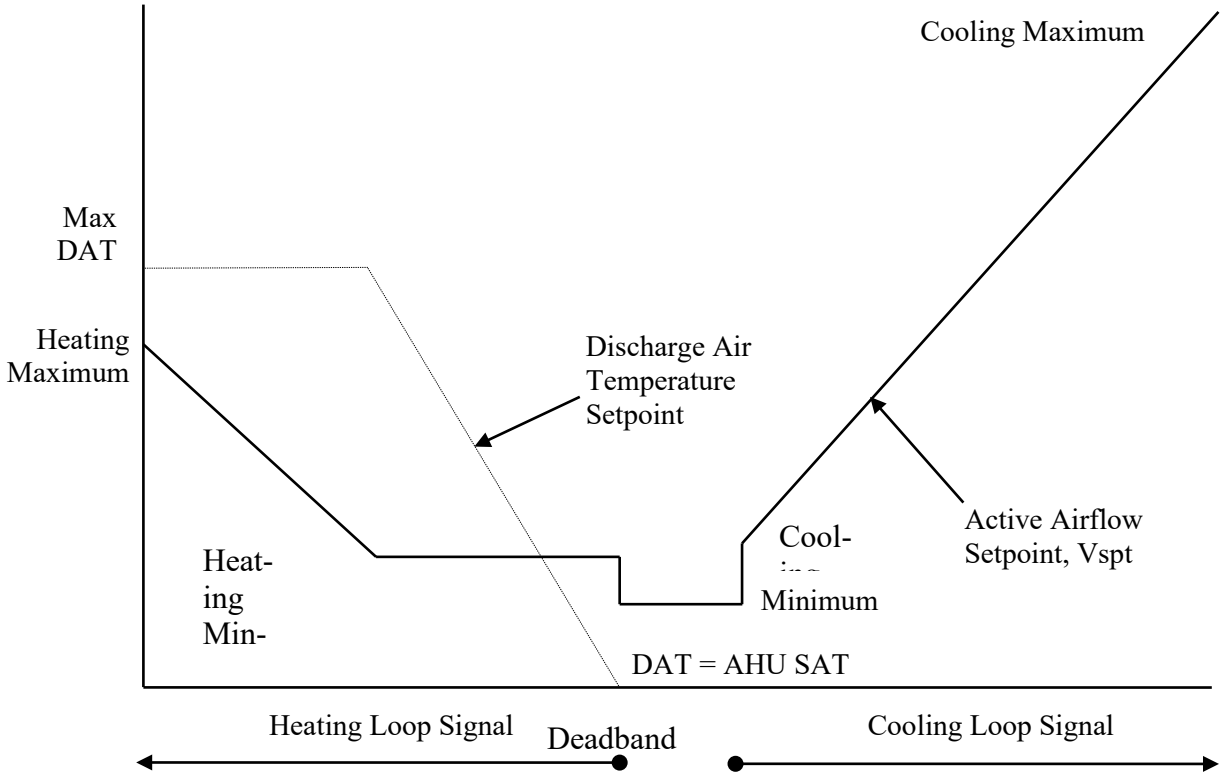
G. BAS shall give the RTU a space static pressure reference and set point, and RTU shall modulate its relief fan as needed.

H. BAS shall give the RTU a DA temp set point and the RTU shall control its own cooling components as needed to maintain DA temp.

I. BAS shall monitor alarms, status, diagnostics, and set points over the BACNET interface.

1.06 VAV BOXES

A. VAV boxes shall have dual maximum and dual minimum set points and operate for DA temp targeting per ASHRAE guideline 36-2021 section 5.6. See diagram



B. When the Zone State is cooling, the cooling-loop output shall be mapped to the active airflow setpoint from the cooling minimum endpoint to the cooling maximum endpoint. Heating coil is disabled unless the DAT is below the minimum setpoint (see Section 5.6.5.4).
   1. If supply air temperature from the air handler is greater than room temperature, the active airflow setpoint shall be no higher than the minimum endpoint.

C. When the Zone State is deadband, the active airflow setpoint shall be the minimum endpoint. Heating coil is disabled unless the DAT is below the minimum setpoint (see Section 5.6.5.4).

D. When the Zone State is heating, the Heating Loop shall maintain space temperature at the heating setpoint as follows:
   1. From 0% to 50%, the heating-loop output shall reset the discharge temperature setpoint from the current AHU SAT setpoint to a maximum of Max delta T above space temperature setpoint. The active airflow setpoint shall be the heating minimum endpoint.
   2. From 51% to 100%, if the DAT is greater than room temperature plus (5°F), the heating-loop output shall reset the active airflow setpoint from the heating minimum endpoint to the heating maximum endpoint.
   3. The heating coil shall be modulated to maintain the discharge temperature at setpoint. (Directly controlling heating off the zone temperature control loop is not acceptable).
   4. When the airflow setpoint is pulse-width modulated per Section 5.2.2, the heating coil and PID loop shall be disabled, with output set to 0 during closed periods.

E. Alarms
   1. Low Airflow
      1. If the measured airflow is less than 70% of setpoint for 10 minutes while setpoint is greater than zero, generate a Level 4 alarm.
      2. If the measured airflow is less than 50% of setpoint for 10 minutes while setpoint is greater than zero, generate a Level 3 alarm.
      3. If a zone has an Importance-Multiplier of 0 (see Section 5.1.14.2.a.1) for its static pressure reset T&R control loop, low airflow alarms shall be suppressed for that zone.
   2. Low-Discharge Air Temperature
      1. If heating hot-water plant is proven ON, and the DAT is 8.3°C (15°F) less than setpoint for 10 minutes, generate a Level 4 alarm.
      2. If heating hot-water plant is proven ON, and the DAT is 17°C (30°F) less than setpoint for 10 minutes, generate a Level 3 alarm.
      3. If a zone has an Importance-Multiplier of 0 (see Section 5.1.14.2.a.1) for its hot-water reset T&R control loop, low-DAT alarms shall be suppressed for that zone.
   3. Airflow Sensor Calibration. If the fan serving the zone is OFF and airflow sensor reading is above the larger of 10% of the cooling maximum airflow setpoint or 50 cfm for 30 minutes, generate a Level 3 alarm.

4. Leaking Damper. If the damper position is 0%, and airflow sensor reading is above the larger of 10% of the cooling maximum airflow setpoint or 50 cfm for 10 minutes while the fan serving the zone is proven ON, generate a Level 4 alarm.
    1. The constant value thresholds for the airflow sensor calibration and leaking damper alarms are a function of the transducer and A/D converter used to measure airflow. The value used should be determined as the minimum accuracy of the transducer and A/D converter combination.
5. Leaking Valve. If the valve position is 0% for 15 minutes, DAT is above AHU SAT by 3°C (5°F), and the fan serving the zone is proven ON, generate a Level 4 alarm.

F. Hot-Water Reset Requests
1. If the DAT is 17°C (30°F) less than setpoint for 5 minutes, send 3 requests.
    1. Else if the DAT is 8°C (15°F) less than setpoint for 5 minutes, send 2 requests.
    2. Else if HW valve position is greater than 95%, send 1 request until the HW valve position is less than 85%.
    3. Else if the HW valve position is less than 95%, send 0 requests.
2. If There Is a Hot-Water Coil and Heating Hot-Water Plant, Heating Hot-Water Plant Requests. Send the heating hot-water plant that serves the zone a heating hot-water plant request as follows:
    1. If the HW valve position is greater than 95%, send 1 request until the HW valve position is less than 10%.
    2. Else if the HW valve position is less than 95%, send 0 requests.

1.07 HEATING WATER SYSTEM

A. Heating water system consists of 2 boilers, sized for approximately 60% of the load each. They shall operate in a lead / lag / standby alternating run time sequence.

B. The heating water system consist of 2 pumps, each sized for 100% capacity and shall operate in a duty /standby alternating run time sequence.

C. Heating water plant sequence shall be programmed per ASHRAE Guideline 36 – 5.21: See below for applicable sections.
1. See Section 3.1.8 for HWSTmax, HW-LOT, HW-MinFlowX, HW-DesFlowX, QbX, B-FiringMinX, PHWFdesign, and SHWFdesign. See Section 3.2.4 for HW-DPmax, LocalHW-DPmax, and B-MinPriPumpSpdStage.
2. Plant Enable/Disable
    1. The Boiler plant shall include an enabling schedule that allows operators to lock out the plant during off-hours, e.g. to allow off-hour operation of HVAC systems except the Boiler plant. The default schedule shall be 24/7 (adjustable).
    2. Enable the plant in the lowest stage when the plant has been disabled for at least 15 minutes and:
        a) Number of Heating Hot-Water Plant Requests > I (I = Ignores shall default to 0, adjustable), and

b) OAT<HW-LOT, and
c) The Boiler plant enable schedule is active.

3. Disable the plant when it has been enabled for at least 15 minutes and:
    1. Number of Heating Hot-Water Plant Requests ≤ l for 3 minutes, or
    2. OAT>HW-LOT + 1°F, or
    3. The Boiler plant enable schedule is inactive.
4. When the plant is enabled:
    1. Open the HW isolation valve of the lead boiler.
    2. Stage on lead primary HW pump per Section 5.21.6.
    3. Once the lead pump has proven on, enable the lead boiler.
5. When the plant is disabled:
    1. Shut off the enabled boiler(s).
    2. For each enabled boiler with headered primary HW pumps, close the HW isolation valve(s) after 3 minutes and disable the operating HW pump(s) per Section 5.21.6.
6. Boiler Staging
    1. Boiler stages shall be defined as follows:
        a) Boiler Stage — Enabled Boilers
        b) 0 — None
        c) 1 — one boi
        d) 2 — two boi

D. Interchangeable boilers shall be lead/lag controlled per Section 5.1.15.3.

E. If a boiler is in alarm, the boiler shall be disabled and after 3 minutes, its HW isolation valve shall be closed.

F. Boilers are staged in part based on the minimum output of a given stage, B-STAGEMIN. Calculate B-STAGEMIN as the largest B-FiringMinX of all boilers in the stage times design capacity of all boilers in the stage.

G. Staging events require that a boiler stage be available. A stage shall be deemed unavailable if the stage cannot be achieved because a boiler required to operate in the stage is faulted per Section 5.1.15.5.b.1.iii or a hot water pump dedicated to that boiler is faulted per Section 5.1.15.5.b.1.i; otherwise the stage shall be deemed available.

H. Staging shall be executed per the conditions below subject to the following requirements:
1. Each stage shall have a minimum runtime of 10 minutes.
2. Timers shall reset to zero at the completion of every stage change.
3. Any unavailable stage (see Section 5.21.3.8) shall be skipped during staging events, but staging conditionals in the current stage shall be evaluated as per usual.

I. Stage up if any of the following is true:
1. Availability Condition: The equipment necessary to operate the current stage are unavailable. The availability condition is not subject to the minimum stage runtime requirement. Or
2. Efficiency Condition: Both of the following are true:

2. Required exceeds 200% of B-STAGEMIN of the next available stage for 10 minutes
3. Hot water flowrate exceeds the minimum flow setpoint of the next available stage (see Section 5.21.8).

3. Failsafe Condition: HW supply temperature is 10°F < setpoint for 15 minutes.

J. Stage down if all of the following are true:
1. Either:
4. Required falls below 110% of B-STAGEMIN of the current stage for 5 minutes; or
5. The minimum flow bypass valve, if provided, is greater than 0% open for 5 minutes.
2. The failsafe stage up condition is not true.
3. Required is less than 80% of the design capacity, QbX, of the boilers in the next available lower stage for 5 minutes.

K. Hot Water Supply Temperature Reset
1. Plant hot water supply temperature setpoint shall be reset using Trim & Respond logic with the following parameters:

Variable	Value
Device	Any HW Pump Distribution Loop
SP0	SPmax
SPmin	90°F for condensing and hybrid boiler plants; 155°F for non-condensing plants
SPmax	HWSTmax
Td	10 minutes
T	5 minutes
I	2
R	Hot-Water Reset Requests
SPtrim	-2°F
SPres	+3°F
SPres-max	+7°F

L. Primary Hot Water Pumps
1. Primary hot water pumps shall be lead/lag controlled per ASHRAE 36-Section 5.1.15.3.
2. Enable lead primary hot water pump when any boiler isolation valve is commanded open. Disable the lead hot water pump when all boiler isolation valves are commanded closed.
3. When any pump is proven on, pump speed shall be controlled by a reverse acting PID loop maintaining differential pressure at HW-DPmax. All pumps receive the same speed signal. PID loop output shall be mapped from minimum pump speed at 0% to maximum pump speed at 100%.

M. Summary Data
1. For each boiler, statistics shall be calculated for runtime, cumulative load (btu), average demand (btu/h), and peak demand (btu/h). All statistics shall be presented on an instantaneous, year-to-date, and previous year basis.
2. For the total plant, statistics shall be calculated for runtime, energy use (btu), cumulative load (btu), average demand (btu/h), peak demand (btu/h), and

actual efficiency (btu/btu). All statistics shall be presented on an instantaneous, year-to-date, and previous year basis.

N. Alarms
1. Maintenance interval alarm when pump has operated for more than 3000 hours as indicated by the Staging Runtime: Level 4. Reset the Staging Runtime interval counter when alarm is acknowledged.
2. Maintenance interval alarm when boiler has operated for more than 2000 hours as indicated by the Staging Runtime: Level 4. Reset the Staging Runtime interval counter when alarm is acknowledged.
3. Boiler alarm: Level 2
4. Low boiler leaving hot water temperature (more than 15°F below setpoint) for more than 15 minutes when boiler has been enabled for longer than 15 minutes: Level 3
5. Pump alarm is indicated by the status input being different from the output command for 15 seconds.
6. Commanded on, status off: Level 2. Do not evaluate alarm until the equipment has been commanded on for 15 seconds.
7. Commanded off, status on: Level 4. Do not evaluate alarm until the equipment has been commanded off for 60 seconds.
8.

1.08 EXHAUST FANS
1. Each general exhaust fan shall have a dedicated adjustable schedule in the BMS. For initial set up, program each to operate continuously when building is scheduled occupied.

1.09 ELECTRIC HEATERS
1. The BAS shall enable the electric heaters to operate to maintain space temperature, with an adjustable deadband, initially set at 65 deg +/- 3 deg F.

1.10 UTILITY METERS

A. Provide additional utility meters to allow the DFCM to meter utilities separately. This shall include the following:
1. Gas Meter – Onicon F-5400 or equivalent
2. Water Meter – Onicon F-4600 or equivalent

B. Provide monitoring of electrical meters and tie into the DFCM Energy Management monitoring system.

1.11 DOMESTIC HOT WATER

A. Domestic hot water re-circulating pump will operate based on an occupied schedule. When in occupied mode, pump will run continuously. Pump will be monitored for status and if there is no status of the pumps when occupied, and this condition is maintained for 30 seconds then an alarm will be generated.

B. Domestic water re-circulating pumps shall be enabled 30 minutes adjustable before building is in occupied mode, and it shall continue running for 30 minutes adjustable in unoccupied mode.

C. Domestic water heater shall operate under factory controls to maintain hot water storage tank setpoint of 140 F (adj.)

1.12 LIGHTING

A. Provide BACNET read/write interface for lighting controls.
1.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.

B. Welding certificates.

C. Field quality-control reports.

D. Operation and Maintenance Data: For pressure regulators to include in operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BrassCraft Manufacturing Company; a Masco company.
b. Conbraco Industries, Inc.; Apollo Div.
c. Lyall, R. W. & Company, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Perfection Corporation; a subsidiary of American Meter Company.
f. Prior approved equal..

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.

4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

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. Vanguard Valves, Inc.
    b. Safe-T-Quake.
    c. Koso
    d. Trembler Tech
    e. Prior approved equal.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded end connections complying with ASME B1.20.1.
8. Wall mounting bracket with bubble level indicator.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Actaris.

b. American Meter Company.
c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
d. Invensys.
e. Richards Industries; Jordan Valve Div.
f. Prior approved equal.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Install fittings for changes in direction and branch connections.

E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

F. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

H. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 22 and 23 Section "Meters and Gages."

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install escutcheons at penetrations of interior walls, ceilings, and floors.

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
e. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated or rough-brass finish.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 22 and 23 Section "Meters and Gages."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 22 and 23 Section "Hangers and Supports."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.

5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 and 23 Section "Mechanical Identification" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 9 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (flat).
d. Color: By owner.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Quick-drying alkyd metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).
d. Color: By owner.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.13 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping shall be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping 2" and larger shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:

1. One-piece, bronze ball valve with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, lubricated plug valve.

END OF SECTION 231123

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SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condensate-drain piping.
4. Air-vent piping.
5. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:

1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 125 psig at 225E F.
2. Air-Vent Piping: Equal to the pressure of the piping system to which it is attached.
3. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.4 SUBMITTALS

A. Product Data: For each type of the following:

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Chemical treatment.
4. Hydronic specialties.

B. Welding certificates.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in operation, and maintenance manuals.

F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.6 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, , black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.3 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 22 and 23 Section "Valves."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 22 and 23 Section "HVAC Instrumentation and Controls."

C. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Flow Design Inc.
    d. Gerand Engineering Co.
    e. Griswold Controls.
    f. Taco.
    g. Tour & Andersson; available through Victaulic Company of America.
    h. Prior approved equal.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum.
11. Maximum Operating Temperature: .

D. Diaphragm-Operated Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump; a division of ITT Industries.
    d. Conbraco Industries, Inc.
    e. Spence Engineering Company, Inc.
    f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.4 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Flexcon
5. Taco.
6. Patterson.
7. Prior approved equal.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 3/4.
5. Discharge Connection: NPS 3/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

2.5 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: Welded steel construction; working pressure; capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

B. Water Treatment shall be provided by Powers Engineering or prior approved equal.

2.6 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (860 kPa).

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, 2 inch and smaller, shall be the following:

1. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, 2-1/2 inch and larger, shall be any of the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, ball valve, and short threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 22 and 23 Section "Valves."

Q. Install unions in piping, and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install nipple and ball valve in blowdown connection of strainers 2-1/2 inch and larger. Match size of strainer blowoff connection for strainers smaller than 2 inch.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 22 and 23 Section "Pipe Expansion Fittings and Loops."

U. Identify piping as specified in Division 22 and 23 Section "Mechanical Identification."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 22 and 23 Section "Hangers and Supports." Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.

E. Support vertical runs at roof, at each floor, and at intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 and 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than above the floor. Install feeder in minimum bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 22 and 23 Section "Meters and Gages."

3.8 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

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SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Bell & Gossett; Div. of ITT Industries.
3. FloFAb
4. PACO Pumps.
5. Patterson Pump Co.; a Subsidiary of The Gorman-Rupp Co.
6. Taco, Inc.
7. Weinman; Div. of Crane Pumps & Systems.
8. Prior approved equal.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. EPDM coupling sleeve for variable-speed applications.

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 ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 22 and 23 Section "Motors."

H. Capacities and Characteristics: See Drawings.

2.3 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast or ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast or ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

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 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 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 22 and 23 Section "Basic Mechanical Materials and Methods."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.3 PUMP INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. 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.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check valve and throttling valve on discharge side of constant volume pumps, and venturi on discharge side of variable volume pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

I. Install check valve and gate or ball valve on each condensate pump unit discharge.

J. Install electrical connections for power, controls, and devices.

K. Ground equipment according to Division 26 Section "Grounding and Bonding."

L. Connect wiring according to Division 26 Section "Conductors and Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
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 the 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.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 232123

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SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure per equipment manufacturers requirements.

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.

B. Welding certificates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:
1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

B. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.

5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

C. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

D. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

E. Moisture/Liquid Indicators:
1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

F. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: See drawings.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.

2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.
5. Prior approved equal.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.

B. Hot-Gas and Liquid Lines: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.

D. Install a full-sized, three-valve bypass around filter dryers.

E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

F. Install thermostatic expansion valves as close as possible to distributors on evaporators.
1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

G. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

J. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

K. Install receivers sized to accommodate pump-down charge.

L. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 22 and 23 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access

doors or panels as specified in Division 8 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

R. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

S. Seal penetrations through fire and smoke barriers according to Division 7 Section "Through-Penetration Firestop Systems."

T. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

U. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

V. Seal pipe penetrations through exterior walls according to Division 7 Section "Joint Sealants" for materials and methods.

W. Identify refrigerant piping and valves according to Division 22 and 23 Section "Mechanical Identification."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 22 and 23 Section "Hangers and Supports."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
    1. Install core in filter dryers after leak test but before evacuation.
    2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
    3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
    4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
    1. Open shutoff valves in condenser water circuit.
    2. Verify that compressor oil level is correct.
    3. Open compressor suction and discharge valves.
    4. Open refrigerant valves except bypass valves that are used for other purposes.
    5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Double-wall round and flat-oval ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.
8. Seismic-restraint devices.

B. Related Sections:

1. Division 22 and 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
2. Division 22 and 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.

1. Static-Pressure Classes:

a. Supply Ducts (except in Mechanical Rooms): 2-inch wg.
b. Supply Ducts (Upstream from Air Terminal Units): 3-inch wg.
c. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
d. Supply Ducts (in Mechanical Equipment Rooms): 2-inch wg.
e. Return Ducts (Negative Pressure): 1-inch wg.
f. Exhaust Ducts (Negative Pressure): 1-inch wg.

2. Leakage Class:

a. Round Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
b. Flat-Oval Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
c. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
d. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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. Lindab Inc.
    b. McGill AirFlow LLC.
    c. SEMCO Incorporated.
    d. Sheet Metal Connectors, Inc.
    e. Spiral Manufacturing Co., Inc.
    f. Metco.
    g. Prior approved equal.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

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. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.
5. Metco.
6. Prior approved equal.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.
e. Prior approved equal.
f. Maximum Thermal Conductivity:

1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

4. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

a. Fan discharges.
b. Intervals of lined duct preceding unlined duct.

c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. 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.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 22 Section "Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

1. For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C, except as follows:

a. Ducts that are located directly in zones they serve.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "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 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 22 and 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
2. Test the following systems:

    a. Supply air.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before insulation application.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 22 and 23 Section "Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel:

B. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless-Steel Ducts: Galvanized steel.
3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

C. Liner:

1. Supply- and Return-Air Ducts: Fibrous glass, Type I.

D. Double-Wall Duct Interstitial Insulation:

1. Supply- and Return-Air Ducts: 1 inch thick.

E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

G. Duct Schedule

1. Rectangular duct with liner:

a. Low pressure supply and return.

2. Rectangular duct wrapped with insulation:

a. Low pressure exhaust and fresh air.

3. Single wall round with wrapped insulation.

a. Low pressure supply and return.

4. Double wall round and flat oval:

a. Medium pressure supply (upstream of VAV).

END OF SECTION 233113

SECTION 233300 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Volume dampers.
   2. High Efficiency Take-Offs.
   3. Turning vanes.
   4. Flexible connectors.
   5. Flexible ducts.
   6. Duct accessory hardware.

B. Related Sections include the following:

   1. Division 22 and 23 Section "HVAC Instrumentation and Controls" for electric and pneumatic damper actuators.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Volume dampers.
   2. High Efficiency Take-Offs.
   3. Turning vanes.
   4. Flexible connectors.
   5. Flexible ducts.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Clifco
4. Flexmaster U.S.A., Inc.
5. Leader
6. McGill AirFlow Corporation.
7. METALAIRE, Inc.
8. Nailor Industries Inc.
9. Penn Ventilation Company, Inc.
10. Ruskin Company.
11. Vent Products Company, Inc.
12. Air Rite.
13. Greenheck.
14. Prior approved equal.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Standard Volume Dampers: Opposed-blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel.
7. Bearings: Oil-impregnated bronze.
8. Tie Bars and Brackets: Aluminum.
9. Tie Bars and Brackets: Galvanized steel.

D. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 HIGH EFFICIENCY TAKE-OFF

A. Factory-manufactured rectangular-to-round or round-to-round 45 degree leading tap fabricated of 24 ga zinc-coated lockforming quality steel sheets meeting requirements of ASTM A 653, with G-90 coating.

B. One inch wide mounting flange with die formed corner clips, pre-punched mounting holes, and adhesive coated gasket.

C. Manual Volume Damper:

1. Single blade, 22 ga minimum.
2. 3/8 inch minimum square rod with brass damper bearings at each end.
3. Heavy duty locking quadrant on 1-1/2 inch high stand-off mounting bracket attached to side of round duct.

D. Approved Manufacturers:

1. HETD-L by Daniel Manufacturing.
2. STO by Flexmaster USA Inc.
3. HET by Sheet Metal Connectors Inc.
4. Hercules.

5. Clifco
6. Air-Rite.
7. Prior approved equal.

2.5 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Available Manufacturers:

a. Ductmate Industries, Inc.
b. Duro Dyne Corp.
c. METALAIRE, Inc.
d. Ward Industries, Inc.
e. Prior approved equal.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.6 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Flex-Weld
4. Ventfabrics, Inc.
5. Ward Industries, Inc.
6. Prior approved equal.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.7 FLEXIBLE DUCTS

A. Manufacturers:

1. Flexmaster U.S.A., Inc.
2. Hart & Cooley, Inc.
3. McGill AirFlow Corporation.
4. Themaflex.
5. Quietflex
6. Prior approved equal.

B. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

H. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

I. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

J. Connect diffusers to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

K. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 22 and 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233300

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SECTION 233423 – EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Centrifugal roof ventilators.
2. Ceiling Mounting Ventilator.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Loren Cook Company ACE-B or equal by
2. Acme Engineering & Mfg. Corp.
3. Aerovent; a Twin City Fan Company
4. American Coolair Corp.
5. Carnes Company HVAC.
6. Greenheck.
7. JencoFan; Div. of Breidert Air Products.
8. Penn Ventilation.
9. Twin City
10. Prior approved equal.

B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Spring loaded, automatic belt tensioning pulley.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in cant and mounting flange.
2. Overall Height: 12 inches.
3. Sound Curb: Curb with sound-absorbing insulation matrix.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Mounting Pedestal: Galvanized steel with removable access panel.
7. Vented Curb: Unlined with louvered vents in vertical sides.

H. Capacities and Characteristics: See drawings.

2.2 CEILING-MOUNTING VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Loren Cook Company. Gemini or equal by.
2. American Coolair Corp.
3. Carnes Company HVAC.
4. Greenheck.
5. JencoFan; Div. of Breidert Air Products.
6. NuTone Inc.
7. Penn Ventilation.
8. Twin City
9. Prior approved equal.

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:

1. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
3. Motion Sensor: Motion detector with adjustable shutoff timer.
4. Manufacturer's standard roof jack or wall cap, and transition fittings.

H. Capacities and Characteristics: See drawings.

2.3 MOTORS

A. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops Insert device having a static deflection of 1 inch. Vibration-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Division 22 and 23 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 22 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

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SECTION 233600 - VARIABLE AIR VOLUME BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Shutoff single-duct VAV boxes (air terminal units).

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.5 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

A. Available Manufacturers:
   1. Price Industries model SDV or equal by.
   2. Carnes.
   3. Carrier
   4. Krueger.
   5. Nailor Industries of Texas Inc.
   6. Titus.
   7. Trane Co. (The); Worldwide Applied Systems Group.
   8. Tuttle & Bailey.
   9. Prior Approved Equal.

B. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

C. Casing: 0.034-inch steel.
   1. Casing Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.
   1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.
   2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

F. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.

G. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in Division 15 Section "HVAC Instrumentation and Controls" and shall have the following features:
1. Damper Actuator: 24 V, powered closed, spring return open.
2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
   a. Proportional, plus integral control of room temperature.
   b. Time-proportional reheat-coil control.
   c. Occupied and unoccupied operating mode.
   d. Remote reset of airflow or temperature set points.
   e. Adjusting and monitoring with portable terminal.
   f. Communication with temperature-control system specified in Division 23 Section "HVAC Instrumentation and Controls."
3. Room Sensor: Wall mounting, with temperature set-point adjustment and access for connection of portable operator terminal.

H. Control Sequence:
1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
2. Factory-mounted and -piped, 5-micron filter; velocity-resetting, adjustable, high-limit control; and amplifying relay.
3. System-powered, wall-mounting thermostat.

2.3 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

D. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. 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 and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions and do the following:
      a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
      b. Verify that controls and control enclosure are accessible.
      c. Verify that control connections are complete.
      d. Verify that nameplate and identification tag are visible.
      e. Verify that controls respond to inputs as specified.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 233600

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SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ceiling-diffusers and wall-mounted registers and grilles.

B. Related Sections include the following:

1. Division 22 and 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 GRILLES AND REGISTERS

A. Adjustable Bar Side Wall Supply Grille:

1. Products:

a. Carnes; RVEA.
b. Krueger; 5815.
c. METALAIRE, Inc., Metal Industries Inc.; 422.
d. Price Industries; LBMR.
e. Titus; 1707.
f. Tuttle & Bailey; VF5.
g. Or equal by:

1) A-J Manufacturing Co., Inc.
2) Anemostat; a Mestek Company.
3) Dayus Register & Grille.
4) Hart & Cooley, Inc.; Hart & Cooley Div.
5) Nailor Industries of Texas Inc.

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Adjustable horizontal spaced 1/4 inch apart.
5. Frame: 1 inch wide.

B. Fixed Face Ceiling Return, Exhaust, or Transfer Air Grille:

1. Products:

a. Carnes; RSLA.
b. Krueger; S85H.
c. Price Industries; 535.
d. Titus; 355RL.
e. Tuttle & Bailey; T70D.
f. Or equal by:

1) A-J Manufacturing Co., Inc.
2) Anemostat; a Mestek Company.
3) Dayus Register & Grille.
4) Hart & Cooley, Inc.; Hart & Cooley Div.
5) Nailor Industries of Texas Inc.

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2 inch horizontal blade spacing.
5. Frame: 1-1/4 inches wide.

2.3 CEILING DIFFUSER OUTLETS

A. Rectangular and Square Ceiling Diffusers:

1. Products:
a. Carnes.
b. Krueger.
c. METALAIRE, Inc., Metal Industries Inc.
d. Price Industries; SPD or equal by.
e. Titus.

f. Tuttle & Bailey.
g. A-J Manufacturing Co., Inc.
h. Anemostat; a Mestek Company.
i. Hart & Cooley, Inc.; Hart & Cooley Div.
j. Nailor Industries of Texas Inc.
k. Prior approved equal.

2. Material: Steel.
3. Finish: Baked enamel, white.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, provide lay-in ceiling module. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

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SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim and accessories for generating hot water.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.

1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.

B. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 50%, and 20% input firing rates at incoming water temperatures ranging from 60°F to 160°F. Test protocols shall conform to industry standards and shall be witnessed and reviewed by an independent, third-party group.

C. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of boiler

1. If submitted material is different from that of the design basis, boiler manufacture shall incur all costs associated with reselection of necessary pumps. Possible differences include, but are not limited to, the pump type, pump pad size, electrical characteristics and piping changes.

D. Shop Drawings: For boilers, boiler trim and accessories, include:

1. Plans, elevations, sections, details and attachments to other work
2. Wiring Diagrams for power, signal and control wiring

E. Source Quality Control Test Reports: Reports shall be included in submittals.

F. Field Quality Control Test Reports: Reports shall be included in submittals.

G. Operation and Maintenance Data: Data to be included in boiler emergency, operation and maintenance manuals.

H. Warranty: Standard warranty specified in this Section

I. Other Informational Submittals

1. 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.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. I=B=R Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.

C. ASME Compliance: Condensing boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".

D. ASHRAE/IESNA 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, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

F. UL Compliance. Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

G. NOx Emission Standards. When installed and operated in accordance with manufacturer's instructions, condensing boilers shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.2; and the Texas Commission on Environmental Quality (TCEQ), Title 30, Chapter 117, Rule 117.465.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.

1.6 WARRANTY

A. Standard Warranty: Boilers shall include manufacturer's standard form in which 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. The pressure vessel/heat exchanger shall carry a 10-year from shipment, pro-rated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.

   b. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from shipment.

   c. All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 18 months from shipment

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lochinvar or equal by
2. Aerco
3. RBI
4. Raypak
5. Prior approved equal

2.2 CONSTRUCTION

A. Description: Boiler shall be natural gas fired, fully condensing, fire tube boiler. Power burner shall have full modulation. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory-fabricated, factory-assembled and factory-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.

B. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 5/8" OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8-inch diameter

C. Pressure Vessel: The boiler water connections shall be flanged 150-pound, ANSI rated. The pressure vessel shall be constructed of SA53 carbon steel, with a 0.25-inch thick wall and 0.50-inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

D. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of a 5-to-1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce less than 16 ppm of NOx corrected to 3% excess oxygen. The burner shall be metal-fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable frequency drive (VFD), controlled cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

E. Boiler shall be capable of variable primary pumping, with minimum flow rates of 25% of the scheduled primary pump flow or lower. Boiler manufacturer shall provide documentation demonstrating that the boiler is capable of operating in a variable primary pumping arrangement at these conditions, with a 40 degree delta T on the water, and without supplemental equipment such as buffer tanks.

F. Minimum boiler efficiencies shall be as follows at a 20 degree delta-T:

EWT	100% Fire	50% Fire
160 °F	86%	86.6%
120 °F	88.5%	89.1%
60 °F	95.5%	97.5%

G. The exhaust manifold shall be of corrosion resistant cast aluminum with a 6-inch diameter flue connection. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

H. Blower. The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.

1. Motors: Blower motors shall comply with requirements specified in Division 1 Section "Common Motor Requirements for HVAC Equipment."

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.

I. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

2.3 CONTROLS

A. Refer to Division 22 and 23, Section “Instrumentation and Control of HVAC.”

B. The boiler controls shall be Underwriters Laboratories recognized.

C. The control panel shall consist of individual circuit boards using surface-mount technology in a single enclosure. These circuit boards shall include:

1. A display board incorporating LED display to indicate temperature and a vacuum fluorescent display module for all message enunciation
2. A CPU board housing all control functions
3. An electric low-water cutoff board with test and manual reset functions
4. A power supply board
5. An ignition /stepper board incorporating flame safeguard control
6. A connector board

Each board shall be individually field replaceable.

D. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.

E. The control panel hardware shall support both RS-232 and RS-485 remote communications.

F. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of eight separate status messages and 34 separate fault messages.

G. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:

1. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.
2. Setpoint Low Limit: Setpoint low limit allows for a selectable minimum operating temperature.
3. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired.

H. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1.

I. The Boiler Manufacturer shall supply as part of the boiler package a completely integrated boiler Control System BCS to control all operation and energy input of the multiple boiler heating plant. The BCS shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485 port. One BCS controller shall have the ability to operate up to 2 boilers.
1. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant.

The ACS shall control the boiler outlet header temperature within +2ºF. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The BCS controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.

2. The BCS shall have the following anti-cycling features:
   - Manual designation of lead boiler and last boiler.
   - Lead boiler rotation at user-specified time interval.
   - Delay the firing/shutting down of boilers when header temperature within a predefined deadband.
3. When set on Internal Setpoint Mode, temperature control setpoint on the BCS shall be fully field adjustable from 50ºF to 190ºF in operation. When set on Indoor/Outdoor Reset Mode, the ACS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.
4. When set on MODBUS Temperature Control Mode, the BCS will operate the plant to vary header temperature setpoint as an external communication utilizing the MODBUS protocol is supplied via the RS-232 port. The BCS controller shall have a vacuum fluorescent display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between central BCS system and individual boilers shall be twisted pair low voltage wiring, with the boilers 'daisy-chained' for ease of installation.

J. Boiler shall be enabled from the snowmelt system controller.

K. In order to ensure complete and comparable bids, boiler supplier shall include all labor, materials, etc. for field installation and programming of controls. After bidding, work may be sub-contacted with electrician or ATC on project

2.4 ELECTRICAL POWER

A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.

B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.

C. Electrical Characteristics: See drawings

2.5 VENTING

A. The exhaust vent must be UL Listed for use with Category III and IV appliances and compatible with operating temperatures up to 220°F, positive pressure, condensing flue gas service. UL-listed vents of Al 29-4C stainless steel or polypropylene flues must be used with boilers.

B. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the boiler and the outdoors.

C. Common Vent and Common Combustion Air must be an available option for boiler installation. Consult manufacturer for common vent and combustion air sizing.

D. Follow guidelines specified in manufacturer's venting guide.

E. Boilers shall be provided with a condensate neutralization kit.

2.6 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 testing.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

1. If boilers are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect fourteen days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting boiler performance, maintenance and operations.

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. Install boilers level on concrete bases. Concrete base is specified in Division 22 and 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

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. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Install piping adjacent to boiler to permit 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 gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.

E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting

1. Install flue venting kit and combustion-air intake.

2. Connect venting full size to boiler connections. Comply with requirements in Division 22 and 23 Section "Breechings, Chimneys and Stacks."

H. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.

B. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.

1. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.

2. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.

3. Controls and Safeties: 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.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests

The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following 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.

4. Provide analysis equipment required to determine performance.

5. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

6. Notify Architect in advance of test dates.

7. Document test results in a report and submit to Architect.

END OF SECTION 235216

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SECTION 237413 - PACKAGED OUTDOOR, CENTRAL- STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes cooling and heating packaged rooftop units.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:

1. Design Calculations: For selecting and designing restrained vibration isolation roof-curb rails.
2. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wiring Diagrams: Power, signal, and control wiring.

C. Startup service reports.

D. Operation and Maintenance Data: For rooftop units to include in operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Units shall be designed to operate with HCFC-free refrigerants.

1.6 COORDINATION

A. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

B. Coordinate size, location, and installation of rooftop unit manufacturer's roof curbs and equipment supports with roof Installer.

1. Coordinate installation of restrained vibration isolation roof-curb rails, which are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier.
2. Trane.
3. York.

4. Daikin
5. Prior approved equal.

2.2 CABINET

A. Construction: Single wall.

B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.

C. Interior Casing: Galvanized steel.

D. Base Rails: Galvanized-steel rails for mounting on roof curb.

E. Service Doors: Hinged access doors with neoprene gaskets.

F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.

1. Thickness: 1 inch.
2. Insulation Adhesive: Comply with ASTM C 916, Type I.
3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

G. Condensate Drain Pans: Formed sections of galvanized-steel sheet designed for self-drainage. Fabricate pans with slopes to preclude buildup of microbial slime.

H. Provide with auxiliary hail guards to protect the condenser fins from storm damage.

2.3 SUPPLY-AIR FAN

A. Fan: Forward-curved centrifugal; statically and dynamically balanced, galvanized steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings.

B. Motor: Open dripproof, single-speed motor.

C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.

D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with elastomeric isolators.

2.4 REFRIGERATION SYSTEM

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Compressors: Scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.

C. EER and COP: as defined by ASHRAE/IESNA 90.1-2019, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Refrigeration System Specialties:

1. Expansion valve with replaceable thermostatic element.
2. Refrigerant dryer.
3. High-pressure switch.
4. Low-pressure switch.
5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
6. Brass service valves installed in discharge and liquid lines.
7. Operating charge of refrigerant.
8. Leak detection for A2L refrigerants.

E. Refrigerant Coils: Evaporator and condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.

1. Capacity Reduction: Circuit coils for interleaved control.
2. Tubes: Copper.
3. Fins: Aluminum.
4. Fin and Tube Joint: Mechanical bond.
5. Suction and Distributor: Seamless copper tube with brazed joints.
6. Source Quality Control: Test to 450 psig, and to 300 psig underwater.

F. Condenser Fan: Propeller type, directly driven by motor.

G. Safety Controls:

1. Compressor motor and outside-coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor and outside-coil fan motors.

2.5 OUTDOOR-AIR INTAKE AND DAMPERS

A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.

B. Damper Operators: Electric.

C. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.

D. Outdoor-Air Intake Hoods: Galvanized steel, with bird screen and finish to match cabinet.

2.6 ECONOMIZER:

A. Provide fully modulating damper motors and controls to position outside and return air dampers so that outside air will be used to satisfy the building cooling load in the economizer cycle and minimum outside air during occupied mode.

B. Low leakage dampers shall ride on nylon bearings.

C. Integrated economizer control shall allow compressors to cycle for additional cooling as needed based on outdoor enthalpy.

D. Damper actuators shall be opposing gear driven, 24 volt, fully modulating design. Plug-in control board shall consist of adjustable minimum positioner, enthalpy setpoint, and DIP switches for setting type of control logic use.

E. Outdoor air hood with filters shall be galvanized steel with a powder coat enamel paint finish electrostatically bonded to the metal.

F. For units 5 tons and under, provide extruded aluminum gravity relief dampers to prevent blow-back and outdoor air infiltration during off cycle.

G. For units over 5 tons, provide Centrifugal power exhaust fan whichever size is standard for size of unit.

H. Provide rainhoods and birdscreens.

2.7 FILTERS

A. Comply with NFPA 90A.

B. Disposable Panel Filters: 2-inch- thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.

1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
2. Frame: Galvanized steel.

2.8 CONTROLS

A. Control equipment and sequence of operation are specified in Division 22 and 23 Section "HVAC Instrumentation and Controls."

B. Factory-wire connection for controls' power supply.

C. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.

D. Unit Controls: Solid-state control board and components with field-adjustable control parameters.

E. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.

F. Unit-Mounted Status Panel:

1. Cooling/Off/Heating Controls: Control operational mode.
2. Damper Position: Indicates position of outdoor-air dampers in terms of percentage of outdoor air.
3. Status Lights:

    a. Filter dirty.
    b. Fan operating.
    c. Cooling operating.
    d. Heating operating.

G. Refrigeration System Controls:

1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.

H. Damper Controls - Integrate with BMS:

1. Wall-mounting pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space served by rooftop unit at minimum 0.05-inch wg.

I. Integral Smoke Alarm: Smoke detector installed in supply and return air. For units 2000 cfm and larger.

J. DDC Temperature Control: Provide with BACNET interface module to BAS for monitoring.

K. Provide also stand-alone control module, and dry contacts for enable, disable, and common alarm through the BMS. Include at minimum the following:

1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:

    a. Room temperature.
    b. Discharge air temperature.
    c. Refrigeration system operating.
    d. Furnace operating.
    e. Constant and variable motor loads.
    f. Monitor variable frequency drive operation.
    g. Monitor cooling load.
    h. Monitor economizer cycles.
    i. Monitor air distribution static pressure and ventilation air volumes.

2.9 VIBRATION ISOLATION SEISMIC CURB

A. Roof curbs shall be constructed of galvanized steel. Curbs are to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit.

1. Unit shall be provided with a heavy duty, one piece vibration isolation curb. Each curb shall have the following features:

a. 1 g seismic restraint and 200 mph wind restraint.
b. Access ports for inspection and adjustment at each spring.
c. 2" deflection springs.
d. High frequency noise isolation.
e. Supply and return duct support hardware.
f. Galvanized steel curb with wood nailer.

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 of rooftop units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where rooftop units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install roof curb on roof structure, according to ARI Guideline B. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing with roof construction.

B. Install restrained vibration isolation roof-curb rails on roof structure according to ARI Guideline B. Install and secure rooftop units on rails and coordinate roof penetrations and flashing with roof construction. Restrained isolation roof-curb rails are specified in Section "Mechanical Vibration and Seismic Controls."

C. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

1. Gas Burner Connections: Comply with requirements in Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.

C. Duct Connections: Duct installation requirements are specified in Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to rooftop units with flexible duct connectors. Flexible duct connectors are specified in Division 22 and 23 Section "Duct Accessories."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to furnace combustion chamber.
2. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
3. Inspect casing insulation for integrity, moisture content, and adhesion.
4. Verify that clearances have been provided for servicing.
5. Verify that controls are connected and operable.
6. Verify that filters are installed.
7. Clean outside coil and inspect for construction debris.
8. Clean furnace flue and inspect for construction debris.
9. Inspect operation of power vents.
10. Purge gas line.
11. Inspect and adjust vibration isolators and seismic restraints.
12. Verify bearing lubrication.
13. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
14. Adjust fan belts to proper alignment and tension.
15. Start unit.
16. Start refrigeration system when outdoor-air temperature is within normal operating limits.
17. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
18. Operate unit for run-in period.

19. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure flue-gas temperature at furnace discharge.
    d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

24. Verify operational sequence of controls.
25. Measure and record the following airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Outdoor-air intake volume.

26. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through outside coil or from outside coil to outdoor-air intake.

27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-limit heat exchanger.
    b. Alarms.

C. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

E. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. 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 outside normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop units. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 237413

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For split-system air-conditioning units to include in operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Units shall be designed to operate with HCFC-free refrigerants.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.
2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Air Conditioning; Div. of Carrier Corporation.
2. Fujitsu.
3. Mitsubishi.
4. LG
5. Daikin
6. Trane Company (The); Unitary Products Group.
7. Prior approved equal.

2.2 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Direct drive, centrifugal fan.

E. Fan Motors: Comply with requirements in Division 22 and 23 Section "Motors."

1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Scroll.
2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 0 deg F.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 22 and 23 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection, including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Additional Monitoring:

1. Monitor constant and variable motor loads.
2. Monitor variable frequency drive operation.
3. Monitor economizer cycle.
4. Monitor cooling load.
5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 4-inch- thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install ground-mounting, compressor-condenser components on polyethylene mounting base.

E. Install roof-mounting compressor-condenser components on equipment supports specified in Division 7 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

F. Install seismic restraints.

G. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 22 and 23 Section "Mechanical Vibration Controls and Seismic Restraints."

H. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
1.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 238126

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SECTION 238232 - ELECTRIC BASEBOARD HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
1. Furnish and install Electric Baseboard heaters as described in Contract Documents.

B. Related Sections

2. Division 26 - Electrical service and connections

1.2 QUALITY ASSURANCE

A. Regulatory Requirements - Units shall be UL listed and comply with NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Baseboard Heater
1. Baseboard type surface mounted complete with cover, back and wall brackets.
2. 16 gauge cold rolled steel cover with heavy duty welded steel louvered grilles.
3. Heating element shall be tubular steel with aluminum fins.
4. Provide boxes at each end and end caps with knock outs for wiring.
5. Units shall be controlled automatically by a remote wall mounted thermostat, line voltage, DPST with positive off and heat anticipation features.
6. Provide with necessary connections and relays to control from remote Thermostat .
7. Finish - Baked-on enamel.

a) Q' Mark heavy duty commercial CBD 500 with T-200 Thermostat or equal by.
b) Berko
c) Raywall
d) Thermador

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's written instructions.
B. Provide factory start-up forms in O&M manuals.

END OF SECTION 238232

SECTION 260100 - 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.

1.3 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.

1.4 COORDINATION:

A. Contractor agrees that any discrepancies between the contract drawings and the contract specifications are found the higher cost option shall be used for bidding purposes and the discrepancy brought to the attention of the Engineer for clarification.

B. 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.

1.5 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.

1.6 PROJECT CONDITIONS:

A. The Contractor shall inspect the job site prior to bidding and familiarize himself with existing conditions which will affect the work. 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.

1.7 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.

I. Provide samples where required in individual sections of this Division.

J. 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.

K. 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.

L. 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. All floor mounted equipment shall be installed and anchored to concrete structural or housekeeping pads.

3.3 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.

3.4 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.

3.5 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."

3.6 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.

3.7 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.

3.8 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.

3.9 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.

3.10 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 260000

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. 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. Verify electrical requirements of equipment on nameplate and installation manual. Ensure that the electrical connections meet the requirements and notify Engineer of any discrepancies.
3. Meet with equipment manufacturers representatives to coordinate equipment installation and electrical connections.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.
1. Minimum Metal Thickness:
a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular, water tight sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. O-Z Gedney
e. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. 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.

L. Underground, Exterior-Wall 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 mechanical sleeve seals. Install water-tight assembly.

1. Slope underground conduits away from building to prevent accumulated water from traveling down conduit into building.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use 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.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

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 and less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:
1. Division 26 Section "Medium-Voltage Cables" for single-conductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.

1.3 DEFINITIONS

A. PV: Photovoltaic.

B. RoHS: Restriction of Hazardous Substances.

C. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Testing Agency Qualifications: Member company of NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 COORDINATION

A. MC Cable shall not be used unless specifically approved by Facilities Management electrical engineer(s) through the University Project Manager in writing prior to bid.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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. Cerro Wire, LLC
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

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. Copper Conductors: 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: Comply with UL 83 and UL 44 for Types THHN-THWN-2, XHHW-2 CT rated, and SO.

F. Aluminum Conductors (NOT APPROVED ON PROJECT): Complying with ASTM B 800 and ASTM B 801.
1. Shall not be used in 100-400 amp branch panelboard feeder applications only.
2. Shall not be used for feeders below 100A or above 400A.
3. Shall not be used for elevator feeders.
4. Shall not be used for mechanical equipment feeders or branch circuits.

G. Aluminum Conductor Insulation: Comply with UL 83 and UL 44 for Type XHHW-2.

H. Cables installed in cable tray shall be rated for “Cable Tray” use, CT listed.

I. Multiconductor Cable: Type SO with ground wire.

2.2 METAL-CLAD CABLE, TYPE MC – NOT APPROVED ON PROJECT

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. AFC Cable Systems, Inc.
   2. General Cable Technologies Corporation.
   3. Southwire Incorporated.
   4. Cerro Wire, LLC
   5. Senator Wire & Cable Company

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Comply with UL 1569.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits
   1. Single circuit and multicircuit with color-coded conductors.
   2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:
   1. Type TFN/THHN/THWN-2: Comply with UL 83.

H. Armor: Steel, interlocked.

2.3 CONNECTORS AND SPLICES

A. 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; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.

B. 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.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Service and Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Panelboard Feeders 100A through 400A: Copper for feeders No. 1 AWG and larger. Stranded No. 1 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

D. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.

B. Feeders: Type THHN-THWN-2, single conductors in raceway. Type XHHW-2 for aluminum feeders.

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 specifically shown otherwise.

E. Neutral Conductors: Provide one neutral conductor for each phase conductor. Shared neutral conductors are not allowed.

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 form 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.

G. Upsizing of Conductors
   1. Branch Circuit Voltage of 120V:
      a. Circuit lengths less than 60 feet: Provide minimum #12 AWG conductor size.
      b. Circuit lengths between 60 feet and 100 feet and/or where more than 3 current carrying conductors are installed in a single raceway: Provide minimum #10 AWG conductor size.
      c. Circuit lengths between 100 feet and 150 feet: Provide minimum #8 AWG conductor size.
      d. Circuit lengths greater than 150 feet: Perform voltage drop calculations and provide conductor size to keep branch circuit voltage drop less than 3% with a 15 amp load.
      e. All lighting circuits feeding site lighting at 120V: Provide minimum #10 AWG conductor size for all conductors including equipment ground and upsize per voltage drop above 100 feet.
   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.
e. All lighting circuits feeding site lighting at 277V: Provide minimum #10 AWG conductor size for all conductors including equipment ground and upsize per voltage drop above 240 feet.

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. Class 1 Control Circuits: Type THHN-THWN-2, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN-2, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Install all conductors and cables in raceways per Division 26 Section, "Raceway and Boxes for Electrical Systems."

B. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

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. Paint to match conduits to surface in finished spaces.

G. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

H. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

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.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Splices for No. 10 AWG and smaller shall be screw on type similar to Scotch or Ideal wing nut connectors.
   2. Crimp on splices designed to be used without wire stripping shall not be acceptable.
   3. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 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 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 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."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
      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.

D. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.

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. Overhead-line grounding.
   2. Underground distribution grounding.
   3. Ground bonding common with lightning protection system.
   4. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATION 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.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70 for grounding and bonding of electrical systems.

B. Comply with UL 467 for grounding and bonding materials and equipment.

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.

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.

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 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. 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. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

C. All lugs used in the building system shall be rated for copper only.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

E. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

F. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

G. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

H. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

I. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

J. Conduit Hubs: Mechanical type, terminal with threaded hub.

K. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

L. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

M. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

N. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

O. Straps: Solid copper, copper lugs. Rated for 600 A.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. 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) in diameter.

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 two bare tinned-copper conductors, No. 4/0 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.
3. Terminate Grounds at manholes and building.

C. Isolated Grounding Conductors:
1. 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.
2. Provide IG conductor in addition to the equipment grounding conductor in circuits and feeders serving IG devices and equipment.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus 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 to specified height above floor; 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.

F. Conduits:
1. All metallic conduits shall be properly grounded and bonded.
2. For the following applications a separate code sized insulated ground conductor (in addition to the equipment grounding conductor), shall be terminated to an insulated/isolated ground bus:
a. Conduits serving a 208/120V panels or other feeders.

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 two driven ground rods through manhole or handhole floor at opposite corners, 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. 4/0 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. Install 4/0 bare copper conductor around entire manhole, ground all connections and ground rods to this conductor. Ground the duct bank ground conductors to this ground ring as well.

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 at each pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground duct bank grounding conductors, encased electrode conductors, re-enforcing rebar of equipment pad and other available grounding electrodes.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.

8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. HVAC Metallic Duct and Pipe Bonding within secure areas: Bond all metallic ductwork and metallic piping within each secure area with #10CU ground and connect to the nearest available ground bus within the secure room.

E. 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.

F. 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.

G. 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.

H. 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.

I. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3-by-100-by-300-mm) grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

J. Fence Grounding: 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. Branch Circuits:
1. Raceways used for single or multiple branch circuits shall include a code sized green insulated ground conductor.
2. Circuits used for isolated ground outlets shall be run in separate raceways; or, shall have a separate green insulated ground conductor installed and tagged with identification at all outlet and junction boxes.

B. 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.

C. Ground Bonding Common with Existing 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.

D. 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. Use exothermic welds for all below-grade connections.
3. 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.

E. 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.

F. 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 gas piping system downstream from equipment shutoff valve.

G. 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.

H. 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.

I. Bonding of Exposed Structural Metal: Bond all exposed structural metal that is not grounded to the service equipment enclosure. The points of attachment of the bonding jumpers shall be accessible.

J. 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.

K. 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 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.8 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. 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.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. 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 120V or 208V equipment: 3 ohm(s).
   5. Substations and Pad-Mounted Equipment: 5 ohms.
   6. Manhole Grounds: 10 ohms.

G. 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. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

B. Related Sections include the following:
   1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
      a. Steel slotted support systems.
      b. Clamps
      c. Hangers
      d. Sockets
      e. Eye nuts
      f. Fasteners
      g. Anchors
      h. Saddles
      i. Brackets
   2. Include rated capacities and furnished specialties and accessories

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details for electrical hangers and support systems and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Nonmetallic slotted channel systems. Include Product Data for components.
   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.

C. Welding certificates.

1.5 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. Ductwork, piping, fittings, and supports.
   3. Structural members to which hangers and supports will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Luminaires
      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.

C. Welding Certificates

1.6 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.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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.
g. Wesanco, Inc.
2. Material: Galvanized steel
3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
7. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. 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.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

F. 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.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
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 in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type 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 except if requirements in this Section are stricter:
1. NECA 1
2. NECA 101
3. NECA 102
4. NECA 105
5. NECA 111

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. 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.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 50 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with two-bolt conduit clamps.

F. 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. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. 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
7. To Light Steel: Sheet metal screws.
8. 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 meet seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

E. Manhole Requirements:
1. On manhole walls install a minimum of three, evenly spaced, flush cast-in horizontal unistrut cable supports. The lowest support shall be at 12" above the finished floor of the manhole, and the remaining two install at 3'-8" and 6'-4" above manhole floor.
2. In addition, install vertical, surface mounted, unistrut cable supports over the cast-in horizontal supports. Vertical supports shall be installed in a minimum of four columns along each long wall and two columns along each short wall.
3. Support each cable at unistrut cable supports with rubber cush-grips.
4. Ring each cable around the manhole before terminating.

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. Provide concrete bases for all floor mounted equipment including but not limited to: transformers, switchboards, generators, switches, cabinets, etc.

B. 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.

C. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Anchor equipment to concrete base.
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 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 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 Sections include the following:
1. Section Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. EMT: Electrical metallic tubing.

C. FMC: Flexible metal conduit.

D. GRC (RGS): Galvanized rigid steel conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. RNC: Rigid nonmetallic 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 the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:
a. Duct entry provisions, including locations and duct sizes.

b. Frame and cover design.
c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Raceway and fitting submittals - Not required.

1.5 INFORMATION 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. Qualification Data: For professional engineer.

C. 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.

D. Source quality-control test reports.

PART 2 - PRODUCTS

2.1 METAL CONDUIT, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. 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. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

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 Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: Comply with NEMA FB 1 and UL 514B; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT: Steel, set-screw or compression type.
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, 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 CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Heritage Plastics
2. AFC Cable Systems, Inc.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Arnco Corporation.
5. CANTEX Inc.
6. CertainTeed Corp.; Pipe & Plastics Group.
7. Condux International, Inc.
8. ElecSYS, Inc.
9. Electri-Flex Co.
10. Lamson & Sessions; Carlon Electrical Products.
11. Manhattan/CDT/Cole-Flex.
12. Niedax-Kleinhuis USA, Inc
13. RACO; a Hubbell Company.
14. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.
4. Basor Electric, Inc.

B. 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.

C. 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.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   3. Erickson Electrical Equipment Company.
   4. Hoffman.
   5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
   6. Old Castle Enclosure Solutions.
   7. O-Z/Gedney; a unit of General Signal.
   8. RACO; a Hubbell Company.
   9. Robroy Industries, Inc.; Enclosure Division.
   10. Scott Fetzer Co.; Adalet Division.
   11. Spring City Electrical Manufacturing Company.
   12. Thomas & Betts Corporation.
   13. Walker Systems, Inc.; Wiremold Company (The).
   14. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.; double-gang, minimum 4-11/16" square boxes with single or double-gang mud ring appropriate for the device and wall plate.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Metal Floor Boxes:
   1. Material: sheet 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.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. CDR Systems Corporation.
   d. NewBasis.
   e. Oldcastle Precast Inc.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC" or "COMMUNICATIONS" as required by service type.
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. 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 where indicated.
      a. Medium-Voltage Duct Banks: Concrete-encased.
      b. Communication Duct Banks: Direct Bury.
      c. Provide wrapped rigid steel conduit for the following conditions:
         1) Penetrations through foundation walls.
         2) Bends greater than 22 degrees.

3) Stub ups, or where underground conduits otherwise become exposed.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
6. Application of Handholes and Boxes for Underground Wiring:
   a. Polymer concrete, SCTE 77, Tier 15 structural load rating.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Above 600V, All Locations: GRC.
2. All Feeders and Service Entrance: EMT.
3. Branch Circuits, Exposed, Not Subject to Physical Damage: EMT.
4. Branch Circuits, Exposed and Subject to Physical Damage: Rigid steel conduit. Raceway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums
5. Branch Circuits, Concealed in Ceilings and Interior Walls and Partitions: EMT.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Damp or Wet Locations: GRC.
8. 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.

C. Minimum Raceway Size:
1. 3/4-inch (21-mm) trade size for power.
   a. 1/2-inch trade size may be used for circuits with a total length of less than 50ft. 1/2" may not be used for homeruns.
2. 1-1/4-inch trade size for outdoor lighting.
3. 1-inch trade size for AV and Data.

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. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C)

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. 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.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. 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.

F. Complete raceway installation before starting conductor installation.

G. Properly ground raceways as specified in Division 26 Section "Grounding and Bonding for Electrical systems."

H. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

I. Install no more than the equivalent of three 90-degree bends in any conduit run except for communication and control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

J. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

K. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

L. Support conduit within 12 inches ((300 mm)) of enclosures to which attached.

M. Raceways Embedded in Slabs on Grade (NOT APPROVED ON PROJECT):
1. 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.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from PVC to GRC before rising above floor.

N. Do not install conduits embedded in elevated slabs.

O. 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.

P. 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.

Q. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

R. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

S. 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.

T. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

U. 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.

V. 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.

W. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 1200-lb (544-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.

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. Conduit extending from interior to exterior of building.
   4. Conduit extending into pressurized duct and equipment.
   5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
   6. 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 semi-recessed 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. Boxes in stud walls: Do not install boxes back to back in stud walls. Allow one stud separation or 24" minimum. Where this is not possible, then provide boxes with UL-listed fire rated and sound rated wrapping.

GG. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

HH. Locate boxes so that cover or plate will not span different building finishes.

II. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

JJ. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

KK. Set metal floor boxes level and flush with finished floor surface.

LL. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

MM. Conduits installed with wrinkles or kinks or otherwise in an unprofessional manner shall be replaced by the contractor at no additional cost to the owner.

3.3 INSTALLATION OF RACEWAYS FOR LOW VOLTAGE SYSTEMS

A. All conduits extending from the floor should extend 1-3" AFF and no more than 2" off any wall.

B. Conduit rows should not exceed two deep

C. Conduits that enter a Telecomm Room (TR) should terminate near the corners to allow for proper racking.

D. All pathways must not exceed 295' from the TR to the com/outlet must not have a bend over 90 degrees or an aggregate of bends in excess of 180 degrees between pull points.

E. Conduit segments will not exceed 100' without a pull point.

F. Conduit runs should be limited to less than 150' and no more than 180 degrees in bends total between pull points.

G. All conduits should be equipped with a pull cord that has a minimum rating of 200lbs.

H. A minimum of 1" conduit is required for all Voice/Data locations

I. Wireless locations should be mounted directly to the ceiling or T-bar. Wall mount locations will be approved on a case by case basis in written form.

J. Pathways should be installed at least 3" of clear vertical space above the ceiling tiles and T-bars to ensure accessibility, and should at no point rest or be supported by any component of the suspended ceiling

K. J-hook supports are not acceptable

L. Underground entrances should not have more than 2 - 90 degree bends between pull points

M. All comm. raceways will have a pull rope installed during initial installation (200lb)

3.4 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Division 31 Section "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 with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
5. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape with detectable metal strip directly above line 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.

3.5 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 and boxes with bottom below the 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 the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.7 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.8 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 260536 - CABLE TRAYS 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. This Section includes steel cable trays and accessories.

1.3 SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.
   1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   2. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
      a. Design Calculations: Calculate requirements for selecting seismic restraints.
      b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

C. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:
   1. Vertical and horizontal offsets and transitions.
   2. Clearances for access above and to side of cable trays.
   3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

D. Field quality-control reports.

E. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Chalfant Manufacturing Company.
2. Cooper B-Line, Inc.
3. Cablofil (Legrand)
4. GS Metals Corp.; GLOBETRAY Products.
5. MONO-SYSTEMS, Inc.
6. MPHusky.
7. PW Industries.

2.2 MATERIALS AND FINISHES

A. Wire Mesh Cable Trays, Fittings, and Accessories: Steel wire mesh/basket type, complying with NEMA VE 1.
1. Carbon steel ASTM A510 grade 1008, electroplated zinc complying with ASTM B633.

B. Sizes and Configurations: Refer to Drawings for specific requirements for types, materials, sizes, and configurations. Where not indicated, provide the following size:
1. 18" wide x 4" deep.

C. Provide trapeze style support for cable trays.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray. Provide factory fittings, elbows, 90s, sweeps, waterfalls, etc. No field modified fittings.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

C. Dividers: Provide factory cable tray dividers including all fittings and connectors compatible with cable tray.
1. All cable trays shall have dividers included to partition the cable tray into two separate sections.

2.4 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

B. Drawings show general cable tray layout and do not detail changes in elevation or offsets required to maneuver around structure and work of other trades. Coordinate cable tray layout with other construction elements and include transitions, offsets and changes in elevation.

C. Remove burrs and sharp edges from cable trays.

D. Install dividers in all cable trays following manufacturer instructions.

E. Fasten cable tray supports to building structure and install seismic restraints.
1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
2. Place supports so that spans do not exceed cable tray ratings with installed weight load.
3. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
4. Support bus assembly to prevent twisting from eccentric loading.
5. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
6. Locate and install supports according to NEMA VE 1.

F. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

G. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 1. Space connectors and set gaps according to applicable standard.

H. Make changes in direction and elevation using standard fittings.

I. Make cable tray connections using standard fittings.

J. Cable Trays Above Accessible Ceilings:
1. Locate bottom of cable tray between 3" - 12" above accessible ceiling tile such that ceiling tile can be removed and cable tray can be accessed.

2. Locate cable tray at least 3" below perpendicular piping and duct work crossing so that top of tray can be accessed.
   a. Maintain 12" minimum clearance above cable tray for its entire length except for direct crossings, but should impact no more than 4ft of the cable tray.
3. Maintain at least 12" separation from lighting fixtures.
4. Maintain at least 3" separation from branch circuits, and 18" separation from feeders.
5. Maintain at least 18" of side clearance for cable tray for access into cable tray.

K. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

L. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

M. Workspace: Install cable trays with enough space to permit access for installing cables.

N. Grounding and Bonding: bond cable tray to telecomm grounding system. Each conduit shall be bonded to cable tray with #8 cable for all low voltage cabling systems utilizing the cable tray.

3.2 CABLE INSTALLATION

A. Install cables only when cable tray installation has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. On vertical runs, fasten cables to tray every 18 inches (457 mm). Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

D. In existing construction, remove inactive or dead cables from cable tray.

E. The inside of a cable tray must be free of burrs, sharp edges, or projections that can damage the cable during installation

F. Elevation changes and offsets must be kept to a minimum

G. Tray should extend at least 1" into the TR then waterfall to 8' to accommodate internal racking

H. When cable tray is used, conduit should extend from the telecom outlet located in the work area, directly to the cable tray.

I. Trays should be supported every 5' and within 24" on each side of a fitting (unless otherwise noted by the manufacture)

J. All metallic cable trays must be grounded, marked and all sections bonded in accordance with applicable codes, standards and regulations

K. Pathways should be kept in common areas to avoid future maintenance occurring in private work areas.

L. Trays should be sized to be at no more than 40% fill.

3.3 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions.
   1. Bond discontinuous sections of cable trays together so that cable tray is electrically continuous.
   2. Bond cable trays to sections of metal raceways that are part of the cable pathway system.

3.4 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:
   1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
   2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
   3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
   4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
   5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
   6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
   7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

3.5 PROTECTION

A. Protect installed cable trays.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
   2. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

END OF SECTION 260536

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS 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 and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High-density plastic boxes.
10. Precast manholes.
11. Cast-in-place manholes.
12. Utility structure accessories.

1.3 DEFINITION

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:
1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

B. Shop Drawings for Factory-Fabricated Handholes and Pull Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Reinforcement details.
   3. Frame and cover design and manhole frame support rings.
   4. Ladder details.
   5. Grounding details.
   6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
   7. Joint details.
   8. Structural Calculations for Manholes: Submit structural calculations based on the 2012 IBC, stamped and signed by a Structural Engineer in the State of Utah.

C. Product Data: For the following:
   1. Duct-bank materials, including separators and miscellaneous components.
   2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Accessories for manholes, handholes, pull boxes, and other utility structures.
   4. Warning tape.
   5. Warning planks.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

E. Product Certificates: For concrete and steel used in precast concrete manholes, pull boxes and handholes, comply with ASTM C 858.

F. Source quality-control reports.

G. Field quality-control reports.

H. ICC Evaluation Reports: For damp-proofing and water-proofing materials, submit ICC evaluation reports to Engineer and DFCM as a deferred submittal.

1.5 QUALITY ASSURANCE

A. Comply with IEEE C2.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Engineer and Owner no fewer than two weeks in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Owner's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and pull boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and pull boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems.
   2. ARNCO Corporation.
   3. Beck Manufacturing.
   4. Cantex, Inc.
   5. CertainTeed Corp.
   6. Condux International, Inc.
   7. DCX-CHOL Enterprises, Inc.; ELECSYS Division.

8. Electri-Flex Company.
9. IPEX Inc.
10. Lamson & Sessions; Carlon Electrical Products.
11. Manhattan Wire Products; a Belden company.

B. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and retained to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.3 PRECAST CONCRETE HANDHOLES AND PULL BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Christy Concrete Products.
2. Cretex Concrete Products West, Inc.; Riverton Division.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Oldcastle Precast Inc.; Utility Vault Division.
6. Utility Concrete Products, LLC.
7. Wausau Tile Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A153 (ASTM A153M) and ASTM A123 (ASTM A123M).

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or pull box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.
2. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing stainless-steel bolts.
a. Cover Hinges: Concealed, with hold-open ratchet assembly.
b. Cover Handle: Recessed.
3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
4. Cover Legend: Molded lettering, "ELECTRIC" or "TELEPHONE" as required for each service.
5. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.
6. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
a. Extension shall provide increased depth of 12 inches (300 mm).

b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

7. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   a. Type and size shall match fittings to duct or conduit to be terminated.
   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
9. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 CORROSION PROTECTION

A. Aluminum shall not be installed in contact with earth or concrete.

3.2 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

B. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Pull Boxes for 600 V and Less:
   1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
   2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
   3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.

B. Manholes:
   1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
   2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.
   3. All new manholes shall be pre-cast concrete units. Where pre-cast cannot be used due to restricted site access or other obstructions, then cast-in-place manholes may be used, however, contractor shall submit shop drawings and design along with structural calculations stamped by a Structural Engineer for review.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.5 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. For turns greater than 30 degrees use manufactured wrapped rigid metal long sweep bends with a minimum radius of 48 inches (1220 mm), both horizontally and vertically, at other locations unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 ft. (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
   2. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall and Manhole Penetrations: Make a transition from underground duct to rigid steel conduit, wrapped in PVC tape at least 10 ft. (3 m) outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Terminate with flush bell ends. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled with Sika "Sikadur Combiflex" sealing system or prior approved equal. Seal spare ducts at terminations with UL approved plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure and seal with silicon sealant.

G. After installation of duct bank, pull a mandrel through each duct to ensure that no debris has collected in the duct. Then install pull cord and label at each end with date installed. Install a plastic conduit plug at each end of the rope and seal the plugs to each end of all unused conduits with silicone sealant.

H. Pulling Cord: Install *2500-lb- mule tape with lineal footage markings* in ducts, including spares.

I. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 ft. (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
      b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
   3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
   4. Mix red dye in concrete..
   5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 4 inches (100 mm) between ducts and exterior envelope wall, 3 inches (75 mm) between ducts for like services, and 24 inches (300 mm) between power and signal ducts.
7. Depth, 600V and Below: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
8. Depth, Above 600V: Install top of duct bank at least 36 inches (1200 mm) below finished grade unless otherwise indicated.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Ribbon: Bury yellow metallic locator ribbon directly above centerline of duct bank 12" below finished grade.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND PULL BOXES

A. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:
1. Install handholes with bottom below the frost line, below grade.
2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
3. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Provide the following and coordinate with rock sump provided under manhole floor.
1. Install grate drains in bottom of manholes where indicated.
2. Install full size drain connection to entry hatch 1-1/2" welded drain couplings.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof

opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Waterproofing: After ducts have been connected and grouted, and before backfilling, waterproof openings, *penetrations*, joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
1. Waterproof joints, connections and openings with "Sikadur Combiflex" sealing system.
2. For new manholes: Apply damp proofing to entire manhole with Henry HE 789 damp proof coating or equivalent.Coordinate first paragraph below with Drawings. Delete second option if nonmetallic cable racks are specified.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.Delete first paragraph below if manhole ladder locations are detailed on Drawings.

G. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

I. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Test mandrel shall be not less than 12 inches long, and diameter shall not be less than 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

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. 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 260548 - VIBRATION AND 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. This Section includes the following:
   1. Isolation pads.
   2. Spring isolators.
   3. Restrained spring isolators.
   4. Channel support systems.
   5. Restraint cables.
   6. Hanger rod stiffeners.
   7. Anchorage bushings and washers.

B. Related Sections include the following:
   1. Division 26 Section "Hangers And Supports For Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading: Refer to project Structural Drawings and Specifications for the following, as defined in the IBC:
   1. Site Class: As indicated in structural project documents
   2. Assigned Seismic Use Group or Building Category.
      a. Component Response Modification Factor: As indicated in structural project documents
      b. Component Amplification Factor: As indicated in structural project documents
   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): As indicated in structural project documents
   4. Design Spectral Response Acceleration at 1.0-Second Period: As indicated in structural project documents

B. Component Importance Factor:
   1. In order to identify systems requiring seismic restraint and to define those from which restraints may be excluded, utility components are assigned an ASCE 7 Importance Factor (Ip) on the basis of the following:
      a. Ip = 1.5

1) essential facilities required for post earthquake recovery – all components required for the continued operation of the facility.
2) Life-safety components which are required to function after a seismic event including all equipment feeding and connected to the life safety branch of the electrical system.
3) All equipment feeding and connected to the stand-by branch of the electrical system.

b. Ip = 1.0 All other components.

1.5 SUBMITTALS

A. Product Data: For the following:
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. 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.
3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
2. Provide Seismic Design Force calculations per ASCE 7- [02, Formulas 9.6.1.3-1 thru 9.6.1.3-3] [05, Formulas 13.3-1 thru 13.3-3].
3. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
4. Field-fabricated supports.
5. 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. 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 DFCM shall be as required by IBC 106.3.4.2.
1. Deferred submittals of seismic restraint of nonstructural components must be submitted to the DFCM Building Official 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 DFCM approval has been received.
3. If seismic restraints of nonstructural components are installed prior to receiving DFCM 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 (switchgear, panelboards, transformers, MCC's etc.).
   b. Conduit racks.
   c. Cable trays.
   d. Lighting Concrete Pole Bases.

D. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Welding certificates.

F. Qualification Data: For professional engineer.

G. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing seismic engineering services, including the design of seismic restraints, that are similar to those indicated for this Project.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. 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) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. ISAT.
6. Loos & Co.; Seismic Earthquake Division.
7. Mason Industries.
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: [Steel tube or steel slotted-support-system sleeve with internally bolted connections] [Reinforcing steel angle clamped] to hanger rod. Do not weld stiffeners to rods.

F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

G. 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.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl 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.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

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.

B. Examine roughing-in of 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 due to 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. Equipment and Hanger Restraints:
1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. 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.

C. 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.

D. 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

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 they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 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.

END OF SECTION 260548

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. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data and Examples: For each major type of label, include dimensions and type of label to be provided. Provide examples of the following labels at a minimum:
1. Panelboard/Switchboard
2. Generator
3. Arc Flash
4. Medium Voltage

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

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. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at More Than 600 V (where exposed):
1. White letters on painted red raceways.
2. Legend: "DANGER HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high letters on 20-inch (500-mm) centers.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

D. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
4. 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.
5. Overall Thickness: 5 mils (0.125 mm).
6. Foil Core Thickness: 0.35 mil (0.00889 mm).
7. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
8. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning 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).

D. Metal-Backed, Butyrate Warning Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; 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).

E. Warning label and sign 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 48 INCHES (1200 MM)."

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.8 CABLE TIES

A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, 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).

2.9 Color: Black. MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select 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 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands 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.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line 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.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply 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.

B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Snap-around labels. Install labels at 30-foot (10-m) maximum intervals.

C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
1. Emergency Power.
2. Power.
3. UPS.

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors. Color coding is based on clockwise rotation.
   a. Conductors No. 6 AWG and below shall be color coded with colored insulation. Larger sizes may be identified by field-applied color-coding conductor tape.
   b. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
      4) Neutral: White.
      5) Neutral A: White w/ Black Stripe.
      6) Neutral B: White w/ Red Stripe.
      7) Neutral C: White w/ Blue Stripe.
      8) Ground: Green.
   c. Colors for 480/277-V Circuits:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
      4) Neutral: Grey.
      5) Neutral A: Gray w/ Brown Stripe.
      6) Neutral A: Gray w/ Orange Stripe.
      7) Neutral A: Gray w/ Yellow Stripe.
      8) Ground: Green.
   d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

E. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.
1. For HV cable in each manhole or transformer vault via a permanently installed metal tag and colored tape. Tag cables with feeder number and

identification at all visible points on phase B. Phasing will be consistent with the rest of the system and shall be marked as follows:
a. Phase 1: Black.
b. Phase 2: Red.
c. Phase 3: Blue.

F. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

G. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. 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.

L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

M. 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.

N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and

protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. 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.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label stenciled legend 4 inches (100 mm) high.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   d. 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.
2. Equipment to Be Labeled:
   a. Enclosures and electrical cabinets.
   b. Access doors and panels for concealed electrical items.
   c. Switchgear.
   d. Switchboards.
   e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
   f. Substations.
   g. Emergency system boxes and enclosures.
   h. Enclosed switches.
   i. Enclosed circuit breakers.
   j. Push-button stations.
   k. Power transfer equipment.
   l. Contactors.
   m. Monitoring and control equipment.

3.3 IDENTIFICATION REQUIREMENTS FOR MEDIUM-VOLTAGE INSTALLATIONS

A. Labeling & ID Tags
   1. General Requirements
      a. install appropriate labels and tags throughout the project's electrical system as directed by USU electric shop.
      b. The purpose of the labels and tags is to provide clear indications of the function of each item, the loads served, routing information, etc., for primary and secondary elements comprising the electrical system.
   2. Permanently Engraved Lamicoid Nameplates
      a. Specify permanently engraved nameplates, labels, or ID tags for a master nameplate, also for manholes, distribution equipment, devices, etc.
      b. Lamicoid nameplates shall be three-ply plastic, 1/16 inch thick. Letters shall be formed by engraving into the outer colored ply, exposing the white or black center-ply. Lettering shall be a minimum of 5/8 inch high, except for MV cable.

END OF SECTION 260553

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SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE AND ARC-FLASH 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 a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1. Study results shall be used to determine coordination of series-rated devices.

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.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and equipment evaluation reports.

3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

4. Arc-flash study input data, including completed computer program input data sheets.
5. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

    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) All studies shall be performed and reviewed prior to substantial completion for the project. Project substantial completion requires final approved submittal. All arc flash labels shall be permanently installed from arc flash study prior to substantial completion.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

B. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1. Include the following:

    a. The following parts from the Protective Device Coordination Study Report:

        1) SKM Model.
        2) One-line diagram.
        3) Protective device coordination study.
        4) Time-current coordination curves.

    b. Power system data.

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, analyzing the arc flash, 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: Subject to compliance with requirements, provide software by the following:
1. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Comply with IEEE 242 and IEEE 399.

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 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:

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.

F. 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.

G. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

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:

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.

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 WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester 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. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

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 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 and under 60A.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

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.

H. 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.

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 and under 60A.

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 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 POWER SYSTEM DATA

A. Obtain all data necessary for the analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584, IEEE 241, IEEE 551, and NFPA 70E as to the amount of detail that is 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. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
5. 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.
6. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
7. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
8. Motor horsepower and NEMA MG 1 code letter designation.

9. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
10. Short-circuit current at each system bus, three phase and line-to-ground.
11. Full-load current of all loads.
12. Voltage level at each bus.
13. Maximum demands from service meters.
14. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
15. 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.
    k. 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.

3.6 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.

3.7 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Use the short-circuit study output and the field-verified settings of the overcurrent devices.

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 240-V ac and 208-V ac systems below 60A.

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.

3.8 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 center.
2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Control panel.
6. Mechanical Equipment over 100A.

3.9 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.10 DEMONSTRATION

A. Contractor shall train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

B. Contractor shall 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 260574

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SECTION 26 0800 - ELECTRICAL SYSTEMS COMMISSIONING

PART 1 – GENERAL REQUIREMENTS

1.1 RELATED WORK

A Specification Section 019113 – "General Commissioning Requirements"
B Specification Section 230800 – "HVAC Systems Commissioning
C Specification Section 220800 – "Plumbing Systems Commissioning"

1.2 Description

A. The purpose of the commissioning process is to provide the Owner/operator of the facility with a high level of assurance that the electrical and associated electrical Systems have been installed in the prescribed manner, and operate within the performance guidelines set in the design intent. The Commissioning Authority shall provide the Owner with an unbiased, objective view of the systems installation, operation, and performance. This process is not to take away or reduce the responsibility of the design professionals or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems to beneficial use by the owner. The Commissioning Authority will be a member of the construction team, cooperating and coordinating all commissioning activities with the design professionals, construction manager, contractors, subcontractors, manufacturers and equipment suppliers.

1.3 Scope

A The electrical systems commissioning shall include a demonstration by the Contractor with the assistance of the Commissioning Authority (CxA) of each piece of equipment to comply with the Owners Project Requirements (OPR) and the Construction Documents (CD). The commissioning process shall demonstrate that each piece of equipment is performing and operating to the OPR and CDs.

B Participants in Electrical Systems Commissioning: Electrical systems shall be conducted with representatives from the following entities (the required participants shall be confirmed with the commissioning agent prior to scheduling the commissioning).

1. General Contractor
2. Owners Representative
3. Electrical Contractor
4. Fire Alarm Contractor

C Major Pieces of Equipment shall be defined as: (While this list is meant to show a representative sample any equipment that uses electrical energy)

1. Network Lighting Controls
2. UPS Systems
3. Coordination Study
4. Generators
5. Automatic Transfer Systems
6. Metering Devices

D Kickoff, Coordination and MEP Meetings

1. Bi-weekly meetings shall be held by the CxA with full participation and attendance of all participants as indicated in the "Participants in Electrical Systems Commissioning" section.
2. These meetings will be held at the CxA convenience and shall be scheduled on a regular basis.
3. Other meetings such as the Commissioning Kick-Off Meeting, Update Meetings, Controls Meeting, Submittal Meetings and other Coordination Meetings shall be attended by those participants as indicated in the "Participants in Electrical Systems Commissioning"

E Submittal Reviews and Meetings

4. The CxA shall review each submittal in Division 26. The contractor shall look and ask for the CxA comments if the comments are not in the return submittal. It is the sole responsibility of the contractor to search out and ask for the CxA comments.
5. For major pieces of equipment, the contractor, sub-contractors, and suppliers shall be in attendance for a submittal review meeting with the Owner and CxA to review the submittal with the Owner and CxA and address any deficiencies.
6. Submittal reviews are NOT an approval but a courtesy review to help validate products submitted is in general compliance with the construction documents. It is the suppliers and contractor's responsibility to verify the supplied product meets or exceeds the construction documents requirements or the supplier is to provide a separate letter noting each of the requirements that has not been achieved and MUST identify they are not in compliance with the construction documents and request a PR. Failure to do so may require modification or replacement of the product when onsite or installed

F Issues Log

1. An issues log shall be kept by the CxA. These issues will intensify issues, defects, improper installations, and deficiencies of the installation and design. The issues log will have the issue, a potential resolution, the sub-contractor responsible, the date of the issue found and the CxA who found the issue.
2. The issues log shall be immediately addressed every week by the contractor. If an issue lags beyond four (4) weeks, the CxA shall request from the Owner and reduction in payment for services by the contractor.
3. When an item is completed and addressed by the contractor or sub-contractor responsible, the party responsible shall sign off and deliver to the CxA for review. The sign off shall include how the contractor addressed the issue and the date in which the contractor addressed the issue. If the issue has not been addressed after re-inspection the contractor shall be liable for the CxA time and efforts as outlined later in this specification.

G Construction Checklist, Pre and Final Functional Testing Checklist, and Startup Checklist

1. The CxA shall develop construction checklist that will be executed by the CxA. The contractors and sub-contractors shall review the checklist for compliance with the

ability of their individual systems. If the contractor or sub-contractors do not provide comments to the CxA then the CxA shall assume their procedures shall not harm nor deteriorate the individual systems. If a problem occurs during testing that causes a piece of equipment of system to malfunction, damage, or any other failure and the contractor or sub-contractor has not in writing opposed such test then the contractor or sub-contractor shall be liable for any damages and delays.

2. The contractor shall fill out checklist called Contractor Readiness checklist. These shall be delivered in the commissioning plan and shall be used to show the CxA that the contractor is ready for Final Function Testing.
3. Startup Sheets shall be delivered to the CxA. The contractor responsible for the piece of equipment is also responsible for delivering those startup sheets to the CxA.
4. Functional Testing shall be attended by the members as defined in "Participants in Electrical Systems Commissioning."
5. Should any of the aforementioned requirements not be met on the date that the commissioning process commences and or if deficiencies are observed during the commissioning process the commissioning will be considered a failure and the deficiencies will be required to be remedied and then addressed in writing prior to requesting a date for re-commissioning. There will be no additional costs allowed to the Contractor for re-commissioning sessions as may be required to address issues that are found to be in non-compliance with the requirements of this specification. The contractor shall be responsible for the CxA additional time due to absence of the member as outlined later in this specification.

H Current Facility Requirements and Operations and Maintenance Document

1. The contractors and sub-contractors shall prepare a documents that contains the following pieces of information. This document shall include the following:

   a. Set points for network lighting controls and building schedules
   b. Set points for Daylighting and Occupancy Sensors
   c. Set lighting levels throughout the building
   d. Any changes in schedules or set points for different seasons, days of the week, and times of day
   e. A systems narrative describing the electrical systems and equipment
   f. a ·preventive ·maintenance ·plan ·for ·electrical ·equipment ·described ·in ·the ·syste ms ·narrative
   g. final installed settings of all adjustable overload protective devices

2. The document shall be delivered to the CxA by the contractor in a Microsoft Word (.doc or .docx) format

I Systems Manual

1. The contractors and sub-contractors shall prepare a documents that contains the following pieces of information. This document shall include the following:

a. Construction record documents and specifications
b. Approved submittals
c. As-built drawings
d. As-built sequence of operation for network lighting controls
e. Recommended schedule for sensor recalibration
f. Equipment operations and maintenance manuals
g. Equipment preventive maintenance schedules
h. Confirmation of completed training for the owner and occupants

J Sky Spark Implementation

1. SkySpark, by Sky Foundry, shall be implemented on this project. The Lighting Controls (booth local, i.e. occupancy sensors daylighting sensors, and network) contractor shall furnish their expertise and time to help with point assignments, communication, and network setup.
2. The Lighting Controls contractor shall spend 40 hours to help implement this process. The Lighting Controls contractor shall furnish an integration specialist to assist with this setup for the 40 hours, a salesperson or representative without knowledge of the project shall not be considered as a specialist.
3. The CxA or a representative appointed by the CxA shall work with the controls contractor, any issues with the Lighting Controls failure to communicate shall not go against the 40 hours.

K Access to Network Lighting Controls System Software

1. The Lighting Controls contractor shall give the CxA their own password and user name for their system.
2. The contractor shall also give Admin Access to the CxA to change settings, review programming, and review settings.

1.4 SYSTEMS TO BE COMMISSIONED

A. This list is not intended to be exhaustive. All division 22 and 23 and any equipment, piping, balancing, controls, etc. that are defined in the entire cumulative sections of division 22 and 23 will go through commissioning. The below list is a representative sample of items that are typically commissioned.

1. Network Lighting Controls
2. Occupancy/Vacancy Sensors
3. Daylighting/Photocell Systems
4. UPS Systems
5. Cable Trays
6. Fire Alarm Systems
7. Overload Protected Devices
8. Coordination Study
9. Generators
10. Automatic Transfer Systems
11. Panelboards
12. Lighting
13. Local Lighting Controls
14. Receptacles

15. Motor Control Centers
16. Transformers
17. Medium Voltage Cabling
18. Raceways
19. Switchgear
20. Main Distribution Boards
21. Switchboards
22. Variable Frequency Drives
23. Medium Voltage Switchgear
24. Metering Devices
25. Surge Protection Systems
26. Power Factor Correction
27. Electrical Distribution
28. Motor Starters
29. Disconnects
30. Hand-Off-Autos

1.5 COORDINATION

A The Commissioning authority shall receive a copy of all construction documents, addenda, change orders, and appropriate approved submittals and shop drawings directly from the Contractor.

B The Commissioning Authority shall disseminate written information and documents to all responsible parties relative to the nature and extent of the communication.

C The Commissioning Authority is primarily responsible to the Owner, and as such, shall regularly appraise the Architect, the Contractor, and the Owner of progress, pending problems and/or disputes, and shall provide regular status reports on progress with each system. Any potential change in the contractual and/or financial obligations of the owner (credits, change orders, schedule changes, etc.) shall be identified and quantified as soon as possible.

D The Commissioning Authority shall coordinate the schedule of commissioning activities with the construction schedule. It is possible that some procedures will be completed before the entire Electrical system is completed.

1.6 SCHEDULE

A Final Commissioning shall not commence on the individual pieces of equipment, Network Lighting Controls, Occupancy and Daylighting Sensors and d other electrical systems until the Contractor Readiness Forms are delivered to the CxA.

B Pre-Functional Commissioning shall commence during the progress of the project. Contractor Readiness checklist do not typically have to be filled out for the CxA to check out these systems. However, the contractor is responsible to inform and schedule the CxA to do Pre-Functional Checks.

C Contractor schedules and scheduling is the responsibility of the Contractor. The Commissioning Authority shall provide commissioning scheduling information to the contractor for review and planning activities.

D The following list is a general set of tasks and criteria along with an approximate duration for each task in regards to the CxA activities. This list is intended to be utilized as a guideline for creating an appropriate schedule for all of the work related to electrical systems commissioning. Three of these activities can be commissioned concurrently at one time. These activities do not include the PFAT Systems. The activities do not include issues that will take additional days to fix.

1. PFAT Systems – PFATs will be completed within 10 business days of the contractor native to CxA to start. We expect these systems to be split up and not told to inspect ALL systems at one time. These will be completed during the typical construction schedule and before Startup.
2. Variable Frequency Drives – 3 business days
3. Network Lighting Controls – 10 business days
4. Occupancy Sensors/Daylighting Sensors – 10 business days
5. Panelboards – 3 business days
6. Receptacles – 7 business days
7. Lighting and Local Lighting Controls – 7 business days
8. Metering – 2 business days
9. Fire Alarm Review – 2 business days

E Most other electrical systems are covered during PFAT phase or HVAC Systems Commissioning and the electrical systems associated with those systems shall be commissioned with the HVAC Systems Commissioning.

F Completion and acceptance of the electrical systems commissioning shall be a condition of Substantial Completion. The building shall be considered 'not ready to utilize for its intended use' until such time that the electrical systems commissioning is successfully completed.

1. In the event that Substantial Completion is given by the owner to the Contractor and Commissioning is not complete then the Warranty period for all pieces of electrical systems shall not begin until the CxA gives their final Commissioning Report.

1.7 Miscellaneous Contractor Responsibilities

A Means and Methods: The contractor is solely responsible for the means and methods of construction. While the CxA shall assist in construction the final responsibility rest solely on the General and Installation Contractor.

B Special Tools and Equipment: While the CxA retains tools in accordance with NEBB BSC Procedural Standards any specialized tools to test the equipment shall be provided to the CxA and used by the Contractor to prove compliance with the OPR and Construction Documents.

PART 2 – PRODUCTS

(NOT USED)

PART 3 – EXECUTION

3.1 commissioning Kickoff meeting

A The CxA shall facilitate a Commissioning Kickoff Meeting after all Electrical, Electrical, and Plumbing subcontractors are under contract with the General Contractor. The CxA shall invite the Architect, Engineers, and Owners Representatives to the meeting.

B The General Contractor shall ensure that the following individuals are in attendance:

2. The Electrical Foreman and Project Manager
3. The Plumbing Foreman and Project Manager
4. The Controls Foreman and Project Manager
5. The Test and Balance Project Manager
6. The Electrical Foreman and Project Manager
7. The Fire Protection Foreman and Project Manager
8. The General Contractor Project Engineer, Superintendent, and Project Manager

C The CxA shall keep meeting minutes and distribute to the individuals present.

3.2 Distribution List

A. The distribution list shall be developed during the Commissioning Kickoff Meeting. This distribution list shall be used for all distribution of commissioning activities. While every effort shall be made to distribute all pertinent information to the sub-contractors by the CxA, the sole responsibility for sub-contractors to receive information rest on the General Contractor.

B If the sub-contractors do not receive information in regards to commissioning activities and the CxA has to reschedule a meeting or appointment or testing activity the contractor shall reimburse the CxA for any expenses as a result.

3.3 Commissioning Plan

A. The Commissioning Plan shall be developed by the CxA and delivered at the conclusion of the submittal process.

B The Commissioning Plan will have the CxA Procedural Standards for testing, the PFAT checklist, the FAT checklist and the Contractor Readiness checklist.

C The sub-contractors and contractors are responsible for reviewing the above checklist and provide comments to the CxA within 30 calendar days of receiving the commissioning plan. During this comment period the comments must be received in writing and the CxA will work with the individual contractors and sub-contractors to ensure the safety of systems. After the 30-day period for comment any additional comments received shall be reviewed by the CxA, however, the subcontractor shall be liable for any cost associated with this review and any delays.

3.4 Submittal Reviews and Submittal Meetings

A The CxA shall review all electrical submittals. It is the responsibility of the contractor to ensure they receive the CxA reviews. The Architect is responsible for delivering the submittals to the CxA, however, in the return submittal if the contractor does not see our review or see an acknowledgement that we did not want to review the submittal it is the responsibility of the contractor to ask for the submittal from the CxA directly.

B The subcontractor, supplier and manufacturer are responsible to submit with initial submittals a line by line submittal compliance document. The compliance document will follow the specification that the submittal is in reference too. The compliance document will have one of the following for each paragraph of the specification: Comply, Exception, or Unable to Comply. With each Exception and Unable to Comply the compliance document will have a detailed explanation.

C The subcontractor, supplier and manufacturer shall attend a submittal review meeting before any piece of equipment shall be ordered. This meeting will be held and conducted by the Commissioning Authority at a place designated by Commissioning Authority (which typically is the General Contractors Trailer). During this meeting the CxA, Engineer, and Owner will review the submittal compliance document.

D The submittals will be marked with Reviewed, reviewed as Noted, defer to Engineer, Note, or Revise and Resubmit. Only Revise and Resubmit items will have the expectation of a re-submittal. In the event that any item is marked as Revise and Resubmit contractor shall pay all expenses incurred by the CX Authority for the re-review process.

3.5 Building Information Modeling (BIM) Reviews

A. The CxA shall review the BIM models at 90% completion for access issues. The file shall be delivered to the CxA in a NavisWorks format (.nwd).

B The contractor may split the review up by floors. Partial floors shall not be reviewed by the CxA until the entire floor is completed to 90%.

C The CxA shall deliver a floor plan with markups on areas of access concern.

D The BIM model shall include all items as outlined in specification 019113 – "General Commissioning Requirements"

3.6 Coordination Meetings (MEP Meetings)

A. The CxA shall conduct a weekly coordination meeting. The electrical, plumbing, test and balance, electrical, and controls contractor shall attend these meetings on a weekly basis.

B The purpose of these meetings is to coordinate installation, commissioning, and testing activities. These meetings will be conducted by the CxA and minutes from these meetings shall be delivered to those individuals described in the Distribution List section.

3.7 Construction Observation and First Installs

A. The CxA shall observe construction activities throughout the construction of the project. The contractors shall be available during these observations for information. An issues log as outlined in Part 1 shall be kept by the CxA.

B First installs are not mockups; they are first installations of individual pieces of equipment that need to be installed in their location. First installs shall be required by the contractor and sub-contractor for the following items:

1. Underground Raceway Installation
2. Aboveground Raceway Installation
3. Floor Boxes
4. Panelboards

C Contractor shall coordinate and not prohibit observations and first installs. Sub-contractors, owner's representatives and engineers shall review the first installs for compliance.

3.8 Contractor Readiness Checklist

A Contractor Readiness Checklist (CRC) shall be delivered by the CxA to the contracting team for the contracting team to fill out. The purpose of the CRCs to inform the CxA of the readiness of the contractor to begin Functional Testing on the electrical system.

B The CxA shall not begin Functional Testing of the system or any equipment until the CRC are received. While some systems can be tested without a complete system the CxA shall have the final say on which can and cannot begin functional testing based on the completeness of the project.

C If the contractor delivers the CRC and the CxA finds the system is not functional then the contractor shall be liable for cost incurred by the CxA.

3.9 Pre Functional Checklist

A The Pre Functional Checklist shall be developed by the CxA and delivered in the commissioning plan.

B The Pre Functional Checklist shall be reviewed by the contractors and sub-contractors and shall be executed by the CxA.

C The CxA shall review 100% of all electrical systems installations.

3.10 Functional Performance Checklist

A The CxA shall execute Functional Performance Checks with the attendance of suppliers, Electrical Contractors, Lighting Controls Contractor and the Fire Alarm Contractor at the request of the CxA.

B Commissioning Authority shall develop and document the commissioning procedures to be used this will be delivered to the contractor in the commissioning plan and is called the Procedural Standards. Include a performance checklist and performance test data sheets for each system based on actual system configuration. These procedures shall be

reviewed by the appropriate contractors and sub-contractors for technical depth, clarity of documentation and completeness. Emphasis shall be placed on testing procedures that shall determine actual system performance and compliance with the design intent.

C The Commissioning Authority shall determine the acceptance procedures for each system within electrical divisions as required. The acceptance procedures shall incorporate the commissioning standards and successful testing results as referred to throughout electrical and electrical specifications.

1. In particular, lighting controls systems including the network lighting controls, occupancy sensors, and daylighting controls.
2. Where NETA is required for test procedures in the other sections, whether the section requires a written test report or not, the electrical contractor shall provide a written report in accordance and outlined to the most current NETA specifications.

D The appropriate contractor and vendor(s) shall be informed of what tests are to be performed and the expected results. Whereas some test results and interpretations may not become evident until the actual tests are performed, all parties shall have a reasonable understanding of the requirements. The Commissioning Plan shall address those requirements and be distributed to all parties involved with that particular system.

E Acceptance procedures shall confirm the performance of systems to the extent of the design intent. When a system is accepted, the Owner shall be assured that the system is complete, works as intended, is correctly documented, and operator training has been performed.

F During the functional performance testing the BMS or ATC contractor shall be in attendance to setup the CxA on the controls system and be in attendance throughout the Sequence of Operation checks.

G The CxA shall review 100% and test 100% of electrical systems as outlined in the systems to be commissioned section.

3.11 Trending

A Trending points shall be outlined in the Procedural Standards as delivered by the CxA in the commissioning plan.

B The network lighting controls contractor shall trend the system in their software for a minimum of four (4) weeks. If the contractor is unable to do four weeks of trending in the system, then the contractor shall reimburse the Owner for CxA expenses to install temporary trending loggers.

3.12 Operation and Maintenance Manuals

A The contractor responsible for Electrical O&Ms shall deliver electronic copies of those O&M to the CxA at 50% billable completion of installed electrical systems. The O&M manuals shall include installation requirements and maintenance requirements.

1. The 50% electrical billable draw shall be held up by the owner at the request of the CxA if the O&M Manuals are not delivered.

B The final O&M Manual shall be reviewed by the CxA before delivery to the Owner. Any deficiencies shall be noted and the contractor shall remedy before final delivery.

C The final O&M must be delivered to the Owner before training shall commence and it shall be one of the requirements for Substantial Completion.

3.13 Current Facility Requirements and Operation and Maintenance Plan

A All contractors as defined in Participants in ELECTRICAL Commissioning shall compile a Current Facility Requirements (CFR) and Operations and Maintenance (O&M) Plan as outlined in LEED v4 EA – "Fundamental Commissioning and Verification".

B The contractors shall provide the following in an editable Microsoft Word Format. (.doc or .docx) in a narrative format for use by the CxA to provide the final CFR and O&M Plan.

1. Building occupancy schedule
2. Set points for all lighting controls equipment
3. Lighting levels throughout the building
4. Changes in schedules or set points for different seasons, days of the week, and times of day
5. Systems narrative describing the electrical systems and equipment
6. Preventive maintenance plan for building equipment described in the systems narrative

3.14 Systems Manual

A All contractors as defined in Participants in ELECTRICAL Commissioning shall compile a Systems Manual.

B The contractors shall provide the following in an editable Microsoft Word Format. (.doc or .docx) in a narrative format for use by the CxA to provide the final Systems Manual. The submittals shall be compiled by section in a .pdf format.

1. Construction record documents and specifications
2. Approved submittals
3. As-built drawings
4. As-built sequence of operation
5. Original set points for all systems commissioned
6. Recommended schedule for sensor recalibration
7. Equipment operations and maintenance manuals
8. Equipment preventive maintenance schedules
9. Confirmation of completed training for the owner and occupants

3.15 TRAINING

A The CxA shall be invited to all electrical training sessions by the General Contractor.

B The training shall not commence until the system has been commissioned and proven ready for training.

C The contractor shall schedule and coordinate training sessions for the Owner's staff for each system. Training shall be in a classroom setting with the appropriate schematics, handouts, and visual/audio training aids on-site with equipment.

D The Commissioning Authority shall review agendas, which shall be submitted at least four weeks before training, and shall audit the training sessions. The agenda shall include but not limited to operational set points, runtime schedules, general operation and maintenance requirements, time and location for the training. Agendas shall conform to the Syllabus section in ASHRAE 0-2013-Appendix P and LEED v4 – EA – "Enhanced Commissioning".

E The training program shall include the following:

1. Emergency instructions and procedures
2. Operation instructions and procedures
3. Troubleshooting procedures
4. Maintenance and inspection procedures
5. Repair procedures
6. Upkeep of the systems manual and associated maintenance documentation logs

F Evaluations shall be done of the training system by the attendees. The evaluations shall reflect ASHRAE 0-2013-Appenix P Evaluation Form.

1. If the Evaluations from the training average rises above 2 (based on 1 being very well trained and 5 not at all trained) then the training shall recommence. All cost for the re-training shall be solely born by the contractor training including any reimbursement to the Owner for the CxA, the Owners Operational Staff, and any other cost born by the owner for failure to comply with requirements.

G The contractor shall provide a schedule for training times and dates. The schedule shall include location, who is training, trainers contact information,

H The appropriate installing contractors shall provide training on all the major systems per specifications, including peculiarities specific to this project.

I The equipment vendors shall provide training on the specifics of each major equipment item including philosophy, troubleshooting, and repair techniques.

J The automatic control vendor shall provide training on the control system per their specification section.

K The contractor shall furnish a final video DVD set, above the owner's requirements as defined elsewhere, to the CxA for their use and ownership and review. Included in those DVDs shall be the sign-in sheet for each training.

3.16 Record Drawings or Redlines

A The CxA shall review the "Redlines" or "Record Drawings" on a bi-weekly basis. Updating redlines shall be a term of a monthly draw and can hold up a monthly draw if the Record Drawings are not updated.

B Record Drawings or Redlines shall be kept in a printed format above and beyond any BIM modeling. If record drawings are being kept on BIM a printed out version on a typical 2D flat sheet of paper large enough to read shall be kept as well in the General Contractors trailer.

C The following requirements shall be meet for Redlines or Record Drawings:

1. Underground: All underground raceways 1.5" and larger or raceways accumulating in 1.5" or larger shall be shown with dimensions from walls (not gridlines) and elevations of the pipe at every ninety or y fitting and marked at every 20 feet on the drawings.
2. Above Ground Concealed: All above ground piping 1.5" and larger or raceways accumulating in 1.5" or larger concealed in hard lid or behind walls shall be dimensioned from walls.
3. Above Ground Accessible or Unconcealed: All above ground piping 1.5" and larger or raceways accumulating in 1.5" or larger shall be documented in the redlines. General location shall be sufficient as long as the general location is in the same area not separated by walls.

D The final redlines shall be reviewed by the CxA before delivery to the Architect.

3.17 Warranty Period and Continuous Commissioning

A The CxA shall provide Continuous Commissioning during the One Year Warranty Period after substantial completion. During this time the CxA shall adjust settings on the BMS for optimization of the system, shall find issues with the system, and shall report issues to the contractors.

B The contractor and sub-contractors shall resolve issues immediately.

3.18 Repeated Work, Testing, and Reviews

A Contractor shall, at no additional cost to the Owner, repeat the complete verification test procedure for each test for which acceptable results are not achieved. Repeat tests until acceptable results are achieved.

B Contractor shall compensate the Owner for costs incurred as the result of tests review or inspection repeated. This includes the costs for the Commissioning Authority, Design Architect, Design Engineers, and Owner--s personnel for billed costs (including travel expenses) for the extraordinary participation of the Owners Representative, Architect, Commissioning Authority or owners staff.

C All retesting, inspection or review of equipment or re reviewing of startup sheets or re re-viewing of electrical systems or re-reviewing of submittals shall be billed at an hour of $250 per hour with a minimum of 4 hours billed per session.

END OF SECTION 260800

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SECTION 260923 - DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Digital Lighting Load Controls
   2. Relay Panels
   3. Emergency Lighting Control (if applicable)

B. Related Sections:
   1. Section 262726 - Wiring Devices Receptacles
   2. Section 265113 – 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. 508 – Industrial Controls
   2. 916 – Energy Management Equipment
   3. 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 (DLM) 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 Fixture Controllers – Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.

4. Digital Occupancy Sensors – Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
5. Digital Switches – Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
6. 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.
7. 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.
8. 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.
9. Digital Lighting Management (DLM) segment network – Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control.
10. 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.
11. 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.
12. Programming and Configuration Software – Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
13. 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.
14. Emergency Lighting Control Unit (ELCU) – 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. 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.
3. 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, 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.

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 limited manufacturer's 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. Fixture controller
      h. Network bridge
      i. Isolated auxiliary relay
      j. Ceiling occupancy sensor (each type used)
      k. Wall mount occupancy sensor (each type used)
      l. Wall switch (each type used)
      m. Interior photocell

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:
   1. Basis of design product: WattStopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:
      a. See Drawings for other approved manufacturers
   1. 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, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories which suit the lighting and electrical system parameters.

2.3 DLM LOCAL NETWORK (Room Network)

A. The DLM 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 DLM local network include:
   1. Plug n' Go™ 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 DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
   3. Push n' 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. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.

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.

E. WattStopper Product Number: LMRJ-Series

2.4 DIGITAL LOAD CONTROLLERS (ROOM AND FIXTURE CONTROLLERS)

A. Digital controllers for lighting loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room load controllers shall be provided to match the room lighting load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard Plug n' Go 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 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.
13. Zero cross circuitry for each load
14. All digital parameter data programmed into an individual room 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 DLM local network ports with integral strain relief and dust cover
   4. WattStopper product numbers: LMRC-101, LMRC-102

C. On/Off/Dimming enhanced Room Controllers shall include:
   1. Real time current monitoring
   2. Multiple relay configurations
      a. One, two or three relays (LMRC-21x series)
      b. One or two relays (LMRC-22x series)
   3. Efficient 250 mA switching power supply
   4. Four RJ-45 DLM 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. (LMRC-21x series)

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. (LMRC-22x series)
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

10. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMRC-221, LMRC-222

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D. 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 DLM 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 DLM local network to drive accessory devices.
b. Power to drive the LMFC Fixture Controller electronics can come from any Room Load Controller, LMPB-100 Power Booster and/or LMZC-301 Zone Controller (described later in the LMCP LIGHTING CONTROL PANELS specification section).

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 DLM 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).
8. WattStopper product numbers: Fixture Controller: LMFC-011, DLM Cable Connector: LMFC-RJ-50-24, Power Booster: LMPB-100

2.5 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.

B. 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 DLM 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. One or two RJ-45 port(s) for connection to DLM 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.

C. 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

D. Units shall not have any dip switches or potentiometers for field settings.

E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

F. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.6 DIGITAL WALL SWITCH OCCUPANCY SENSORS

A. Wallbox mounted passive infrared PIR or dual technology (passive infrared and ultrasonic) digital occupancy sensor with 1 or 2 switch buttons.

B. 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 DLM 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 DLM 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.

C. 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

D. Units shall not have any dip switches or potentiometers for field settings.

E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM 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.
g. WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

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 DLM local network.

D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM 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.
   6. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.8 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 DLM 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 (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62"-1.25" thickness (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 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.
    4. WattStopper Product Number: LMLS-400, LMLS-400-L.

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.
    4. WattStopper Product Number: LMLS-500, LMLS-500-L.

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 con
    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.

7. WattStopper product number LMLS-600

2.9 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 DLM local network.
   6. WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening.

C. Contact closure interface for automatic control via input from limit switches on movable walls (by others).
   1. Operates on Class 2 power supplied by DLM local network.
   2. Includes 24VDC output and four input terminals for maintained third party contract 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; supports LMPS-104 as remote status indicator.
   5. Two RJ-45 ports for connection to DLM local network.
   6. WattStopper part number: LMIO-102

2.10 HANDHELD AND COMPUTER CONFIGURATION TOOLS

A. A wireless configuration tool facilitates optional customization of DLM 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 DLM 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 DLM 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.

C. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

2.11 DLM SEGMENT NETWORK (Room to Room Network)

A. The segment network shall be a linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.
   1. Each connected DLM local network shall include a single network bridge (LMBC-300), 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 supplied by the lighting control manufacturer. The maximum cable run for each segment is 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 (provided by others) either directly, via MS/TP, or through NB-ROUTERs, via BACnet/IP or BACnet/Ethernet. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable.

B. WattStopper Product Number: LM-MSTP, LM-MSTP-DB

2.12 NETWORK BRIDGE

A. The network bridge module connects a DLM 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 Plug n' Go 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 DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM 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

B. WattStopper product numbers: LMBC-300

2.13 LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER

A. HARDWARE:
Provide LMCP 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. LMCP 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 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 DLM 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 LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC-011 Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
    a. The LMZC shall use the same intelligence board as the LMCP relay panel.
    b. The LMZC shall not include relay driver boards or relays.
    c. The LMZC shall have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
    d. The LMZC tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.
    e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug n' Go automatic configuration will establish a unique sequence of operation so that all LMFC-controlled fixtures will turn on to 50% output when any digital occupancy sensor detects motion..
13. WattStopper Product Number: Relay Panels: LMCP8, LMCP24 or LMCP48, Zone Controller: LMZC-301.

B. USER INTERFACE

Each lighting control panel system shall be supplied with at least (1) handheld configuration tool (LMCT-100). 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.
7. WattStopper Product Number: LMCT-100

2.14 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 DLM 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 DLM devices to be imported into the Segment Manager via a single XML based site file from the WattStopper LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered into

LMCS 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 DLM 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 density (power consumption information requires Enhanced DLM Room and Plug Load Controllers with integral current transducers such as LMRC-21x).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 LMCS (such as tagged descriptions for each room) without any custom programming.

b. Ability to set up schedules for DLM 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 DLM rooms as follows:
   1. Support up to 120 network bridges and 900 digital in-room devices (LMSM-3E).
   2. Support up to 300 network bridges and 2,200 digital in room devices, connected via network routers and switches (LMSM-6E).

E. WattStopper Product Numbers: LMSM-3E, LMSM-6E, LM-SUPERVISOR, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

2.15 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

A. PC-native application for optional programming of detailed technician-level parameter information for all DLM 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 LMCI-100 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 1second.
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 (i.e. LMRC-212) 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.

F. WattStopper Product Number: LMCS-100, LMCI-100

2.16 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

B. WattStopper Product Numbers: ELCU-100, ELCU-200.

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.
   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 manufactuerer with test results. Contractor to install any room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty per DLM SEGMENT NETWORK section of specification. 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. 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 260923

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. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   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.

D. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 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.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric. (CED)

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.

E. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: Gray.

F. Taps for Transformers Smaller Than 3 kVA: 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: 220 deg C, UL-component-recognized insulation system.
   1. 3 through 15 KVA shall be rated 115 degrees C rise. 30 KVA and larger shall be rated 150 degrees C rise.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

K. K-Factor Rating: Provide K-4 minimum rated transformers.

L. Wall Brackets: Provide manufacturer's standard wall mount bracket for transformers less than 30KVA.

M. Mounting: Mount transformers less than 30 KVA on wall above door as indicated in drawings.

N. 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. Shall not exceed 45 dB.

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 Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

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 Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

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 10 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. Transient voltage suppression devices, factory installed.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

B. Related Sections include the following:
1. Division 26 Section "Transient Voltage Suppression for Low-Voltage Electrical Power Circuits " for TVSS units that are factory-installed in switchboards.
2. Division 26 Section "Electricity Metering" for metering units that are installed in switchboards.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. 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 schematic and wiring diagrams for power, signal, and control wiring.

C. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
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.

D. 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.

E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 PROJECT 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 temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the 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. Service Conditions: NEMA PB 2, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

D. 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 Engineer and Owner 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 Owner's written permission.
4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.

B. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Coordinate with work of other trades so that piping, ductwork or any equipment foreign to the electrical installation is not located directly above switchboards.

D. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. 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 fewer than one of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Indoor Enclosures: Steel, NEMA 250, Type 1.

E. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

F. 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.

G. Barriers: Between adjacent switchboard sections where normal power is required to be separate from emergency/life-safety power.

H. 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.

I. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

J. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

K. 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.

L. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated copper feeder circuit-breaker line connections.
   2. 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.
   3. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder

and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
6. Lugs: Rated for copper only. CU-AL lugs are not allowed.

M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICES (SPD)

A. SPD Units: Comply with Division 26 Section "Surge Protection Devices."

B. Factory-installed, integral to switchboard within a segregated metal compartment that completely isolates the TVSS from the switchboard interior.

2.3 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-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.
4. Molded-Case Circuit-Breaker (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. 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. For all circuit breaker overcurrent devices with frames rated 1200A or more, provide adjustable instantaneous time delay and interconnect into the arc energy reduction system.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. Fuses are specified in Division 26 Section "Fuses."

2.4 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
1. Potential Transformers: IEEE C57.13; 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: IEEE C57.13; 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.
a. CT's shall be dual wound rated with 50% and 100% taps. Metering shall be connected to the 50% tamp.
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 integral with switchboard as indicated below:
a. See 262713 Electricity Metering specification for approved Manufacturers
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
3. Route ¾" conduit from meter to building cabletray for connection to building network and offsite monitoring.
4. Where current transformers are used, provide engraved label with 3/8"minimum high letters indicating CT ratio and multiplier. Attach label to electrical panel or meter base immediately below meter.
5. Provide CT's with 5 Amp secondary.
6. CT's shall be secured to MDP or transformer with appropriate brackets. Do not hang from secondary feeders.
7. Provide neutral CT in 3 Phase metering schemes.
8. Provide a Current Transformer Test Record for each CT which includes: Ratio; Ratio Correction Factor at 10% and 100% load; Serial Number; Date of Test.

9. Provide test block, fusing, CT's, ratio change, and shorting blocks per standard USU detail.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 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.

2.7 ARC ENERGY REDUCTION SYSTEM

A. For each overcurrent device with a frame size of 1200A or higher, provide an arc energy reduction system complying with 2023 NEC 240.87.

B. System shall consist of an energy-reducing switch with local status indication. Status shall indicate whether the switch is on or off via illuminated blue LED indication lamp. Status indication shall be clearly and permanently marked.

C. Provide permanent label with instruction for operating the arc energy reduction system and warning that any coordination that has been designed into the system may not exist while the arc energy reduction system in "ON."

D. When the arc energy reduction switch is turned "ON" (placed in the "ON" position), the system shall bypass the overcurrent protection device delay settings so that the time delay is "OFF" (0 seconds) and illuminate the switch "ON" indication lamp. When the arc energy reduction switch is turned "OFF" (placed in the "OFF" position), the system shall revert back to the standard overcurrent protection device settings and appropriate delay.

E. Provide all required components for a complete and fully functional arc energy reduction system.

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 APPLICATION

A. Circuit Breaker Types:
1. *Circuit Breakers 400A and larger: Solid-state, adjustable with LSI adjustments. For 480V circuit breakers 1000A and larger provide LSIG adjustments.*
2. *Circuit Breakers less than 400A: Molded case with instantaneous adjustments.*

3.2 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 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 Division 03 Section "Cast-in-Place Concrete."
1. 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.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and 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, transient voltage suppression devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet [within the vicinity of the building main switchboard.].

I. Comply with NECA 1.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "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 Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

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 switchboard 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 stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Switchboard will be considered defective if it does not pass tests and inspections.

F. 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. Engage a factory-authorized service representative to 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.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, accessory, and component indicated. 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. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   7. Include wiring diagrams for power, signal, and control wiring.
   8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

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.

D. 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.

E. Panelboard Schedules: For installation in panelboards

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "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.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

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.

1.6 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.

1.7 PROJECT 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.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
   b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. 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 Engineer and Owner no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Engineer's and Owner's written permission.
3. Comply with NFPA 70E.

1.8 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.

B. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Coordinate with work of other trades so that piping, ductwork or any equipment foreign to the electrical installation is not located directly above panelboards.

D. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. 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.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets as indicated.
   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 Areas: NEMA 250, Type 4X.
      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. Hinged Front Cover: Entire front trim hinged to box and with standard door within door cover.
   3. Finishes:
      a. Panels and Trim: 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.
   4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:
   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
   4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Lugs: rated for copper only.
   3. Main and Neutral Lugs: Mechanical type.
   4. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   5. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   6. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

I. 208 Volt Panels- All 208 volt panels and distribution boards shall include both a bonded and insulated ground bus. The insulated ground bus is intended to provide an isolated ground system for sensitive equipment.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric. (CED)

B. Panelboards: NEMA PB 1, power and feeder 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; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices: Fused switches.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric. (CED)

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 within door style. Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

E. Covers: Hinged front cover (door-in-door) type.

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-replicable electronic trip; and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I^2t response.
   4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
   6. Molded-Case Circuit-Breaker (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 materials.
      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. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
      f. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
      g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
      h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. For all circuit breaker overcurrent devices with frames rated 1200A or more, provide adjustable instantaneous time delay and interconnect into the arc energy reduction system.

C. 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 Division 26 Section "Fuses."
   2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
   3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2.6 ARC ENERGY REDUCTION SYSTEM

A. For each overcurrent device with a frame size of 1200A or higher, provide an arc energy reduction system complying with 2023 NEC 240.87.

B. System shall consist of an energy-reducing switch with local status indication. Status shall indicate whether the switch is on or off via illuminated blue LED indication lamp. Status indication shall be clearly and permanently marked.

C. Provide permanent label with instruction for operating the arc energy reduction system and warning that any coordination that has been designed into the system may not exist while the arc energy reduction system in “ON.”

D. When the arc energy reduction switch is turned “ON” (placed in the “ON” position), the system shall bypass the overcurrent protection device delay settings so that the time delay is “OFF” (0 seconds) and illuminate the switch “ON” indication lamp. When the arc energy reduction switch is turned “OFF” (placed in the “OFF” position), the system shall revert back to the standard overcurrent protection device settings and appropriate delay.

E. Provide all required components for a complete and fully functional arc energy reduction system.

PART 3 - EXECUTION

3.1 APPLICATION

A. Circuit Breaker Types:
   1. Circuit Breakers 400A and larger: Solid-state, adjustable with LSI adjustments. For 480V circuit breakers 1000A and larger provide LSIG adjustments.
   2. Circuit Breakers less than 400A: Molded case with instantaneous adjustments.

3.2 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install floor-mounted panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 80 inches above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.
1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub five 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub five 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade. Include pull strings in empty conduits.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

K. Comply with NECA 1.

L. Fuse Selection and Installation: Verify connected load(s) and selection of fuse sizes for each disconnect switch prior to selection and installation.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads and location in the building; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. 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.

B. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards 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 component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

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. Electricity meters.

B. Meters shall be connected to the Building Automation System (BAS) utilizing modbus protocol for building wide metering in compliance with the Utah State High Performance Building Standard requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Dimensioned plans and sections or elevation layouts and wiring diagrams.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
   1. Application and operating software documentation.
   2. Software licenses.
   3. Software service agreement.
   4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.6 QUALITY ASSURANCE

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.

1.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

1.8 COORDINATION

A. Electrical Service Connections:
   1. Coordinate with utility companies and utility-furnished components.
      a. Comply with requirements of utility providing electrical power services.
      b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 ELECTRICITY METERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the following or prior approved equal.
   1. Schweitzer Engineering Laboratories (SEL) SEL-735 Power Quality Meter
      a. 0735vx10941CXXXXXX16101XX
   2. Other approved meters subject to compliance with requirements include the following:
      a. Schneider ION series
      b. Siemens ION
      c. EATON
      d. GE

B. General Requirements for Electricity Meters:
   1. Comply with UL 1244.
   2. Meters shall meet or exceed accuracy in compliance with ANSI C12.20.
   3. The meter shall support 3-Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
   4. The meter shall accept universal voltage input.
   5. Meter shall be designed for operation with 60 HZ system.
   6. The meter's surge withstand shall conform to IEEE C37.90.1.
   7. The meter shall be user programmable for voltage range to any PT ratio.
   8. The meter shall accept a burden up to 0.36VA per phase, Max at 600V, and 0.014VA at 120 Volts.
   9. The meter shall accept a voltage input range of up to 300 Volts Line to Neutral, and up to 520 Volts Line to Line.
   10. The meter shall accept a current reading of up to 11 Amps continuous.
   11. The meter shall have color-coordinated voltage and current inputs.
   12. The meter shall have a phasor diagram that clearly shows wiring status.
   13. Enclosure: Type 1 where enclosure is required. Meter shall be installed integral with switchboard or panelboard wherever possible.

14. Identification: Comply with requirements in Section 26 0553 "Identification for Electrical Systems."
15. Sensors: Current-sensing type, with current output, selected for optimum range and accuracy for meters indicated for this application.
16. Type: solid core or split core with ratio accuracy of at least +/- 1% full scale.

C. General Requirements for main service and main switchboard metering Electricity Meters:
1. Memory Backup: Unit shall have data-logging capability.
2. Provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.
3. Meter shall provide Harmonics %THD (% of total Harmonic Distortion), including current, voltage, and power harmonics to the 63rd order harmonic.

D. General Requirements for sub metering Electricity Meters:
1. Memory Backup: Unit shall have 32 MB of memory/data-logging capability.
2. Provide sampling at 16+ samples per cycle on all channels measured readings simultaneously.

E. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset. The display shall be capable of displaying all three phases simultaneously and have a selection button on the face of the meter to cycle through the measured parameters.

F. CT's shall be 5 amp secondary and shall be secured with appropriate brackets.

G. CT's shall be dual wound rated with dual taps at 50% and 100% rating. Meters shall be connected to 50% tap.

H. Provide neutral CT in all distribution systems where a neutral exists.

I. The meter shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (Class 0.2%) and ANSI C12.201(Class 0.2%).
1. The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.

J. Meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.

K. The main meter for each distribution voltage (both 480/277 and 208/120) shall include a test switch with inline fusing. Test switch shall be capable of access from the front of the switchboard without exposure to bus and main switchboard interior through a separate door or cover that only exposes the test switch and fusing.
   1. Test block shall be equivalent to Milbank TS10-0111.
   2. Provide inline fuse holder and fuses for between bus taps and meter test block.
   3. Provide solid core CT's wherever possible.

L. Meter shall include 2 independent communications ports on the back and face plate, with advanced features.
   1. One port, through backplate, shall be an RJ45 port, providing 100BaseT Ethernet communication speaking Modbus TCP, and a Web server.
   2. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a remote laptop PC without need for a communication cable.

M. The meter shall provide user configured fixed window or rolling window demand. This shall allow user to set up the particular utility demand profile.
   1. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
   2. All other parameters shall offer max and min capability over the user selectable averaging period.
   3. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.

N. The meter shall support power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available.
   1. Meter power supply shall accept burden of 10VA max.
   2. Meter shall provide upgrade rate of 100msec for Watts, Var and VA. All other parameters shall be 1 second.

O. Communication: Meter shall have native MODBUS protocol.
   1. Meter shall provide a minimum of 40 embedded MODBUS Objects consisting of standard voltage, current, and power parameters, including kW and kWH.

P. Communication: Meter shall have native Modbus TCP protocol.
   1. Meter shall provide a minimum of 40 embedded Modbus Objects consisting of standard voltage, current, and power parameters, including kW and kWH. Objects shall be readily identifiable.

Q. Compatibility with other devices or systems: The electricity meter is intended to be a part of the building wide BAS. As such it is required to be fully compatible with the BAS. This requires that all the variables indicated in the schedule below can be accessed from the BAS.

R. Schedule of required electrical metering points:

S.	Parameter (Metering Point)	T.	Units
U.	Energy Consumption	V.	kWH
W.	Real Power	X.	kW
Y.	Reactive Power	Z.	kVAR
AA.	Apparent Power	BB.	kVA
CC.	Power Factor	DD.	
EE.	Voltage, Line to Line	FF.	Volts
GG.	Voltage, Line to Neutral	HH.	Volts
II.	Current	JJ.	Amps
KK.	Real Power Phase A	LL.	kW
MM.	Real Power Phase B	NN.	kW
OO.	Real Power Phase C	PP.	kW
QQ.	Voltage Phase A-B	RR.	Volts
SS.	Voltage Phase B-C	TT.	Volts
UU.	Voltage Phase C-A	VV.	Volts
WW.	Voltage A-N	XX.	Volts
YY.	Voltage B-N	ZZ.	Volts
AAA.	Voltage C-N	BBB.	Volts
CCC.	Current Phase A	DDD.	Amps
EEE.	Current Phase B	FFF.	Amps
GGG.	Current Phase C	HHH.	Amps
III.	Present Demand (subinterval)	JJJ.	kW
KKK.	Present Demand	LLL.	kW
MMM.	Peak Demand	NNN.	kW

OOO. Present Reactive Power (subinterval)	PPP. kVAR
QQQ. Present Reactive Power	RRR. kVAR
SSS. Peak Reactive Power	TTT. kVAR

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with all manufacturers equipment installation instructions.

B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Where current transformers are used, provide an engraved label with 3/8" minimum high letters indicating CT ratio and multiplier. Attach label to electrical panel or meter enclosure next to meter.

D. Provide a ¾" conduit from the meter to the nearest building telecomm room.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Provide a current transformer test record for each CT which includes:
1. Ratio
2. Ratio correction factor at 10% and 100% load
3. Serial Number
4. Date of test

C. Tests and Inspections:
1. Verify proper operation and measurement of current transformers and document CT ratios for each electricity meter.
2. Verify proper operation and measurement of power meters. Provide calibration certificates to owner after start-up is completed.

D. Metering will be considered defective if it does not pass tests or inspections.

E. Document all settings for all metering devices and include with test and inspection reports.

F. Prepare test and inspection reports.

3.3 TRAINING

A. Provide a minimum of 2 hours of training for the Owners maintenance staff. Coordinate the time of this training with the owner at the time of project close-out.

END OF SECTION 262713

SECTION 262726 - 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. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Twist-locking receptacles.
   3. Snap switches and wall-box dimmers.
   4. Pendant cord-connector devices.
   5. Cord and plug sets.
   6. Floor service outlets, poke-through assemblies, and multioutlet assemblies.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 SUBMITTALS

A. Product Data: For each type of floor service outlet, poke-through assembly, and multi-outlet assembly and all colors for all devices.
   1. Finish and Color Submittal: Provide a complete finish and color submittal package with all finish and color options for each device available for the project. Architect shall provide selections based on this separate submittal.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Service/Power Poles: One for every 10, but no fewer than one.
2. Poke-Through, Fire-Rated Closure Plugs: One for every ten floor service outlets installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles and in the Wiring Device Schedule:
1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
1. Products: Subject to compliance with requirements, provide products from the manufacturers listed in the Wiring Device Schedule.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped. UL listed for weather-resistant with "WR" listing marked visibly on face.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide products from the manufacturers listed in the Wiring Device Schedule.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; L520R.
      b. Hubbell; HBL2310.
      c. Leviton; 2310.
      d. Pass & Seymour; L520-R.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; IG2310.
      b. Leviton; 2310-IG.
   2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. 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.

2.5 TAMPER-RESISTANT RECEPTACLES

A. Description: Tamper resistant receptacles shall be provided as required by NEC. These locations include, but are not limited to:
   1. Dwelling Units and Dormitories
   2. Child care facilities
   3. Clinics, medical and dental buildings and outpatient facilities
   4. Subset of assembly occupancies (Gyms, pools, auditoriums, conference rooms, courtrooms, multipurpose, restaurants, etc.)

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
   1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
   2. 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.

2.7 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
   2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide products from the manufacturers listed in the Wiring Device Schedule.

C. Pilot Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 2221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymour; PS20AC1-PLR for 120 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 2221L.
b. Hubbell; HBL1221L.
c. Leviton; 1221-2L.
d. Pass & Seymour; PS20AC1-L.
2. 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.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 1995.
b. Hubbell; HBL1557.
c. Leviton; 1257.
d. Pass & Seymour; 1251.

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.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 1995L.
b. Hubbell; HBL1557L.
c. Leviton; 1257L.
d. Pass & Seymour; 1251L.

2.9 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Provide full range of finished metal wall plates as selected by the Architect, including satin-finished stainless steel.

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 locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant , die-cast aluminum with lockable cover. Weatherproof while in use type.

2.10 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. Finish: brushed aluminum metal cover finish. Provide carpet insert where used in carpet installations.

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 Category 5e jacks for UTP cable.

2.11 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
3. Square D/ Schneider Electric.
4. Thomas & Betts Corporation.
5. Wiremold Company (The).

B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
1. Service Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.
2. Size: Selected to fit nominal 6-inch cored holes in floor and matched to floor thickness.
3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
4. Closure Plug: Arranged to close unused 6-inch (75-mm) cored openings and reestablish fire rating of floor.
5. Finish: Brushed aluminum metal cover finish.

2.12 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.

2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with brushed aluminum metal finish.

D. Wire: No. 10 AWG.

2.13 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.

c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. 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 down, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the bottom.

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. 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 bottom. 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 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
2. Emergency Outlets: Outlets installed on emergency power circuits shall be red. Other permanent identification of emergency outlets is acceptable only upon written approval from someone having authority in that jurisdiction.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
   2. Test Instruments: Use instruments that comply with UL 1436.
   3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 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. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

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SECTION 262726.1 - WIRING DEVICE SCHEDULE

Wiring Device Schedule

Note to Bidders: Comply with Section 262726 of the specifications. The catalog numbers listed below have been carefully prepared with the assistance of the manufacturer's representatives with the objective of assisting the bidders in determining the quality and ratings of the wiring device specified; however, the catalog numbers may not be complete or accurate. In addition, the color of the wiring device is not intended to be determined by the catalog numbers listed below, but shall be selected by the Architect as indicated in the specification. Each manufacturer prior to bidding shall compare catalog numbers shown with the description and shall notify the Architect/Engineer of any discrepancies.

NEMA	DESCRIPTION	CATALOG NUMBERS
NEMA 5-20R	20A, 125V 2 pole 3 wire duplex grounding receptacles. Nylon or Lexan Faces. Back and side wired. Comply with FS W-C-596 and UL 498.	Bryant 5352 Hubbell CR5352 Leviton 5352 P&S 5352
NEMA 5-20R GFCI	20A, 125V 2 pole 3 wire duplex feed thru GFCI receptacles UL-listed with indicator light. Nylon or Lexan decorator faces. Back and side wired. Internal components shall comply with FS W-C-596 where applicable. Comply with UL 498 and UL 493.	Bryant GFR53FT Hubbell GF5352 Leviton 6898 P&S 2091 S
NEMA 5-20R AFCI/GFCI	20A, 125V 2 pole 3 wire duplex feed thru AFCI/GFCI receptacles UL-listed with indicator light. Nylon or Lexan decorator faces. Back and side wired. Internal components shall comply with FS W-C-596 where applicable. Commercial Grade. Comply with UL 498 and UL 943.	Bryant AFGFR Hubbell AFGF Leviton P&S
NEMA 5-20R Isolated Ground	20A, 125V 2 pole 3 wire isolated ground duplex grounding receptacles. Nylon or Lexan faces. Back and side wired. Comply with FS W-C-596 and UL 498.	Bryant 5362IG Hubbell CR5352IG Leviton 5362 - IG P&S IG6300
NEMA 5-20R Waterproof (Weatherproof in use) GFCI	20A, 125V 2 pole 3 wire duplex feed thru GFCI receptacles with UL-listed and marked "WR" weather resistant; indicator light; Comply with FS W-C-596 and UL 498. Fully gasketed, metal weatherproof while in use enclosure. Plastic covers are not acceptable.	Leviton M5979-0GY cover With the following devices: Hubbell BR20WR Bryant CBRS20WR
NEMA 5-20R Weatherproof GFCI	20A, 125V 2 pole 3 wire duplex feed thru GFCI receptacles with UL-listed and marked "WR" weather resistant; Nylon or Lexan Faces. Back and side wired. Comply with FS W-C-596 and UL 498. Cast aluminum and UL listed for wet locations.	Appleton U-Line/Contender ENRC 21201 With the following devices: Hubbell BR20WR Bryant CBRS20WR

NEMA 5-20R With USB	20A, 125V 2 pole 3 wire grounding, dead-front duplex receptacle with 2 USB ports at 3 amp, 5 VDC, Type C, 2.0.	Hubbell USB20C5 Bryant Leviton
NEMA 5-20R COPS (GFCI AS REQUIRED)	20A, 125V 2 pole 3 wire duplex grounding receptacles. Nylon or Lexan Faces. Back and side wired. Comply with NEC 708, FS W-C-596, UL 498, UL943.	Hubbell HBL8300ILR Bryant Leviton
Blank Face GFCI Device	20A, 125V blank GFCI devices, UL-listed with LED indication. Back and side wired. Nylon or Lexan decorator faces.	Leviton X7590 Cooper VGFD20 Hubbell GFBF20LA P&S 2084
20A Single Pole	20A single pole 125V-277V standard toggle switch labeled as complying UL standard 20 and with Federal Specification W-S-896. Provide Nylon or Lexan face, back and side wired. Rated 1 HP 120V.	Hubbell CS1221 Leviton 1221 P & S 521 Bryant 4901
20A Three-way	20A three-way 125V-277V standard toggle switch labeled as complying UL standard 20 and with Federal Specification W-S-896. Provide Nylon or Lexan face, back and side wired. Rated 1 HP 120V.	Hubbell CS1223 Leviton 1223 P & S 523 Bryant 4903
20A Four-way	20A four-way 125V-277V standard toggle switch labeled as complying UL standard 20 and with Federal Specification W-S-896. Provide Nylon or Lexan face, back and side wired. Rated 1 HP 120V.	Hubbell CS1224 Leviton 1224 P & S 524 Bryant 4904
20A Double Pole	20A double pole 125V-277V standard toggle switch labeled as complying UL standard 20 and with Federal Specification W-S-896. Provide Nylon or Lexan face, back and side wired. Rated 2 HP 240V. Double pole.	Hubbell CS1222 Leviton 1222 P & S 522 Bryant 4902

END OF SECTION 262726.1

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FARMINGTON, UT 84025

SECTION 262743 - ELECTRIC-VEHICLE CHARGING EQUIPMENT

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 EVSE that provides AC Level 1 and Level 2 EV charging.

1.3 DEFINITIONS

A. EV: Electric vehicle.

B. EV Cable: The off-board cable containing the conductor(s) to connect the EV power controller to the EV that provides both power and communications during energy transfer.

C. EV Charger or EV Charging Equipment: See "EVSE."

D. EV Connector: A conductive device that, when electrically coupled to an EV inlet, establishes an electrical connection to the EV for the purpose of power transfer and information exchange. This device is part of the EV coupler.

E. EV Coupler: A mating EV inlet and connector set.

F. EV Inlet: The device in the vehicle into which the EV connector is inserted, and a conductive connection is made for the transfer of power and communication. This device is part of the EV coupler.

G. EVSE: Electric-Vehicle Supply Equipment. It includes the EV charging equipment and conductors, including the ungrounded, grounded, and equipment grounding conductors and EV cables, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for transferring energy between the premise wiring and the EV.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for EV charging equipment.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For EVSE.

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. Detail fabrication and assembly of mounting assemblies for EV charging equipment.
4. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For EVSE.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Area plans and 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. Structural members to which equipment will be attached.
2. Electrical service.
3. Communications service, including wireless communications equipment.

B. Seismic Qualification Data: Certificates, for EVSE, 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.

D. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For EVSE to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating manuals.
2. Program Software Backup: On USB, CD, Cloud, or approved media, complete with configuration files.
3. Device address and password list.

4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 FIELD CONDITIONS

A. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.

B. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not exceeding minus 22 to plus 122 deg F (minus 30 to plus 50 deg C).
2. Altitude: Not exceeding 6600 feet (2000 m).

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EVSE that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: Three year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. ChargePoint.
2. Siemens
3. Enphase (Clippercreek)
4. BTC Power
5. EnelX (JuiceBox)
6. Approved equal prior to bid

B. Basis of Design:
1. ChargePoint CT4021

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: EVSE 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 when subjected to the seismic forces specified."

B. Ambient Temperature: Minus 10 to 104 deg F (Minus 23 to plus 40 deg C).

C. Relative Humidity: Zero to 95 percent.

D. Altitude: Sea level to 6000 feet (2000 m).

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

F. Surge Withstand: 6 kV at 3000 A.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

H. EV Charging Levels:

1. Single vehicle, AC Level 1 at up to 1.7 kW per vehicle.
2. Single vehicle, AC Level 2 at up to 19.2 kW per vehicle.
3. Dual vehicles, AC Level 2 at up to19.2 kW per vehicle.

2.3 EVSE DESCRIPTION

A. Comply with NFPA 70.

B. Comply with:

1. UL 2231-1.
2. UL 2594.
3. SAE J1772 for SAE combo chargers.
4. CHAdeMo for CHAdeMo chargers.
5. OCPP 1.6J (upgradeable to OCPP 2.0.1)
6. ISO 15118

C. Comply with ADA-ABA Accessibility Guidelines.

D. Metering: Nonrevenue grade meter.

E. Input Power:
1. 30 A or 40A as called out in drawings, 208/240-V ac, 60 Hz, single-phase services per charger. Or as indicated on drawings.
2. Dual circuits shall be interlocked.

F. Integral GFCI.

G. Auto-GFCI fault retry.

H. EVSE Mounting: As indicated on Drawings.

I. Enclosures:

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. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
d. Composite.
e. Powder coat.
f. Lockable.
g. Tamper resistant.

J. EV Cable and Connectors:

1. SAE J1772 connector.
2. Double connectors with locking holster.
3. 25-foot (7.5-m) cable with cable management system.
4. Field-replaceable connector and cable assembly.

K. Status Indicators:

1. LEDs to indicate power, charging, charging complete, system status, faults, and service.

L. Display Screen:

1. Daylight viewable, UV-protected display with human-machine interface capability.
2. Displays power, charging, charging complete, remote control, system status, faults, and service.

M. Networking:

1. WAN Communications: Cellular.
2. LAN Communications: Modbus.
3. Capable of remote configuration and reporting.

2.4 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by utilizing cushioning materials or foam or 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for EVSE electrical conduit to verify actual locations of conduit connections before equipment installation.

C. Examine pavement for suitable conditions where EVSE will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 413.

B. Concrete Base Mounting:

1. Install EVSE on 6-inch (150-mm) nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

    a. 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.
    b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    d. Install anchor bolts to elevations required for proper attachment to supported equipment.
    e. Secure EVSE to concrete base according to manufacturer's written instructions.

2. Install EVSE on 12-inch (300-mm) nominal-diameter and 48-inch- (1200-mm-) deep concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

    a. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    b. Install anchor bolts to elevations required for proper attachment to supported equipment.
    c. Secure EVSE to concrete base according to manufacturer's written instructions.

C. Wall Mounting:

1. Install EVSE, so that its receptacles or holders are not less than 18 inches (450 mm) and not more than 4 feet (1.2 m) above finished floor.
2. Mount EVSE to steel slotted supports 1-1/4 inches (32 mm) in depth. Orient steel slotted supports vertically.
3. Ensure that EVSE is plumb and rigid without distortion of box.
4. Secure EVSE according to manufacturer's written instructions.

D. Pole Mounting:

1. Allow a minimum of 24 inches (600 mm) of clearance around EVSE.
2. EVSE receptacles or holders shall be not less than 24 inches (600 mm) and not more than 4 feet (1.2 m) above finished grade.
3. Mount EVSE plumb and rigid without distortion of enclosure.
4. Secure EVSE according to manufacturer's written instructions.

E. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

F. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
2. Comply with requirements for underground raceways and enclosures specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems."

G. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

I. Disconnect: Install disconnect in a readily accessible location according to Section 262816 "Enclosed Switches and Circuit Breakers."

J. Circuit Breakers: Comply with Section 262816 "Enclosed Switches and Circuit Breakers."

K. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking from enclosures and components.

L. Secure covers to enclosure.

M. Cybersecurity:

1. Software:

a. Coordinate security requirements with IT department.
b. Ensure that latest stable software release is installed and properly operating.
c. Disable or change default passwords to password of at least eight characters in length, using a combination of uppercase and lower letters,

numbers, and symbols. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

a. Coordinate location and access requirements with IT department.
b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
c. Disable dual network connections.

3.3 CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Comply with grounding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

C. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

D. 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.

E. Verify that all electrical connections have been made according to the manufacturer's instructions. Remove all burrs, shavings, and detritus from inside the enclosure.

F. After confirming all connections, install covers and tighten fasteners to according to manufacturer's instructions.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 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. Perform tests and inspections.

C. Tests and Inspections:

1. For each unit of EVSE, perform the following tests and inspections:

a. Unit self-test.
b. Operation test with load bank.
c. Operation test with EV.
d. Network communications test.

D. EVSE will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain EV charging equipment.

END OF SECTION 262743

SECTION 262813 - 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 control circuits, enclosed switches, panelboards, switchboards, enclosed controllers and motor-control centers.
   2. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, 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.
   5. Coordination charts and tables and related data.
   6. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," 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.
   4. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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. Comply with UL 248-11 for plug fuses.

1.5 PROJECT 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.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

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.

2.4 MECHANICAL EQUIPMENT

A. Provide current limiting fuses on all large mechanical equipment rated 60 Amps and above to reduce fault current values at equipment to below 5,000 AIC.

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. Feeders: Class J, time delay.
   2. Motor Branch Circuits: Class RK5, current limiting, time delay.
      a. Confirm with manufacturer cutsheets.
   3. Elevator Branch Circuits: Class RK1 or RK5, current limiting, time delay.
      a. Confirm with manufacturer cutsheets.
   4. Other Branch Circuits: Class J, time delay.
   5. Control Circuits: Class CC, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Fuse Selection and Installation: Verify connected load(s) and selection of fuse sizes for each disconnect switch prior to selection and installation.

C. Install spare-fuse cabinet(s). Locate in the vicinity of the building main distribution panel.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - 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 switches.
4. Molded-case circuit breakers (MCCBs).
5. Molded-case switches.
6. Enclosures.
7. Elevator Power Module Shunt-Trip Fused Disconnects

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 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."

1.5 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include 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 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.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

C. 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.

D. 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.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. 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.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source 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 a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.7 PROJECT 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).

B. Comply with NFPA 70E.

1.8 COORDINATION

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.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. 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.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
   1. All lugs shall be rated copper only.

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. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   5. Hookstick Handle: Allows use of a hookstick to operate the handle.

6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 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.
1. All lugs shall be rated copper only.

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. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. 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.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. 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^2t response.

F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

G. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

H. 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.

2.4 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:
1. Standard frame sizes and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
   4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2.6 ELEVATOR SHUNT-TRIP FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc. - Power Module PS

B. Provide shunt-trip fused disconnect switch with all necessary relay(s), control transformer and other options, as shown on drawings and listed below:
   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.
   5. 100VA/120V control power transformer with primary and secondary fuses.
   6. Isolation relay (3PDT, 10amp, 120V). 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.)
   7. 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)
      f. NEMA 1 Enclosure.

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.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices. Verify connected load(s) and selection of fuse sizes for each disconnect switch prior to selection and installation.

E. Location: Equipment disconnecting means shall be immediately next to the equipment which it services.

F. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "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.

3.4 FIELD QUALITY CONTROL

A. 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.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 262816

SECTION 262913 - ENCLOSED CONTROLLERS

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 the following enclosed controllers rated 600 V and less:
   1. Full-voltage manual.
   2. Full-voltage magnetic.
   3. Reduced-voltage solid state.
   4. Multispeed.

B. Related Section:
   1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

G. SCR: Silicon-controlled rectifier.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed controllers 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."

1.5 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
   1. Show tabulations of the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Nameplate legends.
      d. Short-circuit current rating of integrated unit.
      e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
      f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Seismic Qualification Certificates: For enclosed controllers, 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.

D. Field quality-control reports.

E. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for enclosed controllers and installed components.
   2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
   3. Manufacturer's written instructions for setting field-adjustable overload relays.
   4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

F. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.6 QUALITY ASSURANCE

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 NFPA 70.

C. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

1.8 PROJECT 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).

B. Comply with NFPA 70E.

1.9 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Siemens Energy & Automation, Inc.
      d. Square D; a brand of Schneider Electric.
   2. Configuration: Nonreversing.
   3. Flush or surface mounting.
   4. Red pilot light.

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Siemens Energy & Automation, Inc.
      d. Square D; a brand of Schneider Electric.
   2. Configuration: Nonreversing.
   3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
   4. Surface mounting.
   5. Red pilot light.

D. Magnetic Controllers: Full voltage, across the line, electrically held.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Siemens Energy & Automation, Inc.
      d. Square D; a brand of Schneider Electric.
   2. Configuration: Nonreversing.
   3. Contactor Coils: Pressure-encapsulated type.
      a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   5. Control Circuits: 24 or 120-V ac, as required by the control circuit; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      a. CPT Spare Capacity: 100 VA.

6. Solid-State Overload Relay:
   a. Switch or dial selectable for motor running overload protection.
   b. Sensors in each phase.
   c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
   d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
   e. Analog communication module.
7. N.C./N.O., isolated overload alarm contact.
8. External overload reset push button.

E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric.
2. Fusible Disconnecting Means:
   a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
3. Nonfusible Disconnecting Means:
   a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
4. MCP Disconnecting Means:
   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
   d. N.C./N.O. alarm contact that operates only when MCP has tripped.
   e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
5. MCCB Disconnecting Means:
   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
e. N.C./N.O. alarm contact that operates only when MCCB has tripped.

2.2 MULTISPEED MAGNETIC CONTROLLERS

A. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
c. Siemens Energy & Automation, Inc.
d. Square D; a brand of Schneider Electric.
2. Configuration: Nonreversing; consequent pole or two winding types as required by the motor being controlled.
3. Contactor Coils: Pressure-encapsulated type.
a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
4. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 24 or 120-V ac, as required by the control circuit; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
a. CPT Spare Capacity: 100 VA.
6. Compelling relays shall ensure that motor will start only at low speed.
7. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
8. Decelerating timer relays shall ensure automatically timed deceleration through each speed.
9. Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.
10. Solid-State Overload Relay:
a. Switch or dial selectable for motor running overload protection.
b. Sensors in each phase.
c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

11. N.C./N.O., isolated overload alarm contact.
12. External overload reset push button.

2.3 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 3R.
   3. Kitchen and Wash-Down Areas: Type 4X, stainless steel.
   4. Other Wet or Damp Indoor Locations: Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.4 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
      a. Push Buttons: Covered, lockable types; maintained or momentary as indicated.
      b. Pilot Lights: LED types; colors as indicated; push to test.
      c. Selector Switches: Rotary type.

B. N.C./N.O. auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

E. Cover gaskets for Type 1 enclosures.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or

mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch (100-mm) nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
   1. 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.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible-switch enclosed controller.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

G. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
   2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. 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.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect and Owner before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect and Owner before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

E. Set field-adjustable circuit-breaker trip ranges.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION 262913

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

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.

B. Work includes the complete installation, electrical connections, testing, and commissioning of the Variable Frequency Drive systems (VFDs.)

C. The contractor shall provide specified VFD harmonic mitigation and system testing as part of these VFD requirements.

D. VFD harmonic mitigation equipment shall be included as part of the VFD package.

1.2 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections:
1. Division 26 Section "Motor-Control Centers" for VFCs installed in motor-control centers.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. IGBT: Insulated-gate bipolar transistor.

F. LAN: Local area network.

G. LED: Light-emitting diode.

H. MCP: Motor-circuit protector.

I. NC: Normally closed.

J. NO: Normally open.

K. OCPD: Overcurrent protective device.

L. PCC: Point of common coupling.

M. PID: Control action, proportional plus integral plus derivative.

N. PWM: Pulse-width modulated.

O. RFI: Radio-frequency interference.

P. TDD: Total demand (harmonic current) distortion.

Q. THD(V): Total harmonic voltage demand.

R. VFC: Variable-frequency motor controller.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs 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."

1.5 SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. Custom Shop Drawings: (standard factory sales brochure/data is not acceptable) For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
   1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Enclosure types and details.
      d. Nameplate legends.
      e. Short-circuit current (withstand) rating of enclosed unit.
      f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
      g. Specified modifications.
   2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

C. Harmonic Test Prototype Report: Submit prototype test report for each VFC and filter method combination for this project. Show total harmonic distortion levels in voltage and current for a range of frequencies: 25%, 50%, 75% and 100% of 60 Hz.

D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show

VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

E. Qualification Data: For qualified testing agency.

F. Seismic Qualification Certificates: For VFCs, 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.

G. Product Certificates: For each VFC, from manufacturer.

H. Source quality-control reports.

I. Field quality-control reports.

J. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
   2. Manufacturer's written instructions for setting field-adjustable overload relays.
   3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
   4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
   5. Schematic drawings.
   6. Catalog sheets.
   7. Diagrams/pictures showing actual components and parts numbers.
   8. Test Certificates.
   9. Warranty information.
   10. Listing of service personnel responsible for warranty repairs.

K. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 QUALITY ASSURANCE

A. Provide UL 508 listing on assembled drive.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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 NFPA 70.

E. Listed and carry the label of at least one of the following:
1. UL.
2. ETL.

F. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.7 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
2. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
3. Humidity: Less than 95 percent (noncondensing).
4. Altitude: Not exceeding 6000 feet (1800 m).

B. Comply with NFPA 70E

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 3 years minimum from date of vendor start-up.
   2. Warranty shall include the entire VFD system including harmonics.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three 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. Indicating Lights: Two of each type and color installed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following approved suppliers (manufacturers):
   1. Energy Management Corporation (Mitsubishi) Motor Drives International
   2. Long Building Environments/Bisel (Yaskawa)
   3. Midgley-Huber (ABB)
   4. Dan Foss

B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Constant torque and variable torque.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means, overcurrent and overload protection, and harmonic filter; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Do not provide manual bypass within VFC.

F. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

G. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

H. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: Equal to or greater than the AIC rating of gear feeding the drive. Where AIC rating is unknown a minimum of 65 kA shall be provided.
7. Ambient Temperature Rating: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
8. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
9. Humidity Rating: Less than 95 percent (noncondensing).
10. Altitude Rating: Not exceeding 6000 feet (1800 m). Ensure drive is derated for elevation above 3300 feet and rated at full capacity up to 5000 feet elevation.
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability for high overload capacity (constant torque) drives: 1.1 times the base load current indefinitely; 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
13. Overload Capability for normal overload capacity (variable torque) drives: 1.1 times the base load current indefinitely; 1.2 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
14. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
15. Speed Regulation: Plus or minus 5 percent.
16. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
17. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

I. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

J. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
2. Signal: Pneumatic.

K. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

L. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

M. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

N. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

O. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

P. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

Q. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

R. Integral Input Disconnecting Means and OCPD: Motor circuit protector type circuit breaker that is externally operable from the outside of the VFD panel.

1. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
2. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
3. NC/NO alarm contact that operates only when circuit breaker has tripped.

S. VFD shall include Interlock capabilities with local disconnect switch at motor when VFD is remote (not within sight) of motor(s) being controlled.

T. Permanently label all internal wiring.

U. Control voltage shall be 120V.

V. Provide fire alarm fan/VFD shutdown input.

W. Doors must not require special tools to open.

X. Provide a terminal block for VFD feeders to connect to, provide factory wiring between terminal block and VFD output terminals.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators or other acceptable status indication displaying the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. VFD Fault light

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
1. Not required, BAS shall be used to track and time stamp.

D. Indicating Devices: Digital displayand additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:
   1. Electric Input Signal Interface:
      a. A minimum of two programmable analog inputs: 0- to 10-V dc; 4- to 20-mA dc.
      b. A minimum of six multifunction programmable digital inputs.
   2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
   3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
      a. 0- to 10-V dc.
      b. 4- to 20-mA dc.
      c. Potentiometer using up/down digital inputs.
      d. Fixed frequencies using digital inputs.
   4. Output Signal Interface: A minimum of two programmable analog output signal(s) (0- to 10-V dc and 4- to 20-mA dc), which can be configured for any of the following:
      a. Output frequency (Hz).
      b. Output current (load).
      c. DC-link voltage (V dc).
      d. Motor torque (percent).
      e. Motor speed (rpm).
      f. Set point frequency (Hz).
   5. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      a. Motor running.
      b. Set point speed reached.
      c. Fault and warning indication (overtemperature or overcurrent).
      d. PID high- or low-speed limits reached.
   6. Remote Switch
   7. Termination points on a terminal strip for field connections:
      a. Safeties Interlock (N.C. contacts located remote)
      b. Remote Start/Stop Contact (N.O. contacts located remote).
      c. Remote VFC Fault Contacts (N.C.).
      d. Remote VFC Enable Contacts (N.O.).
      e. Remote Electronic Signal Input.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
   1. Number of Loops: Two.

G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
   1. Network Communications Ports: Ethernet and RS-422/485.
   2. Embedded BAS Protocols for Network Communications: Provide capability for all of the following, and coordinate exact type with the BAS installer; protocols accessible via the communications ports:
      a. ASHRAE 135 BACnet
      b. Modbus/Memobus

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Factory installed integral to the VFC enclosure as one UL listed assembly:
   1. Motors Less than 15 HP: AC line reactors with a minimum of 3% impedance and DC choke.
   2. Motors 15 HP and Larger shall have harmonic correction of 12% THID current or less and 3% voltage distortion or less at the input of the VFD terminals. This shall be accomplished by using Harmonic filters or a minimum of 12 pulse drive that will comply with the power quality performance requirements. A harmonic test will be performed by an independent third party. If the manufacturer fails to meet the harmonic limits, they will replace the VFD system at their expense with another VFD system meeting these requirements.

B. Output Filtering: Integral output filter where VFC is located greater than 50' (15 m) from the motor it is controlling.

C. Filter/Transformers shall be factory wired.

2.4 OPTIONAL FEATURES

A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications, when overload protection activates.
   1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.

2.5 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1 filtered and force ventilated.
   2. Outdoor Locations: Type 3R filtered and force ventilated.
   3. Kitchen and wash-Down Areas: Type 4X.
   4. Other Wet or Damp Indoor Locations: Type 3R filtered and force ventilated.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.6 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
      a. Push Buttons: Covered; maintained or momentary.
      b. Pilot Lights: LED types; push to test.
      c. Selector Switches: Rotary type.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
   1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Cooling Fan and Exhaust System: NEMA 1 enclosure for VFD's beyond 25 HP supply fan, with composite intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.

E. Ventilated, NEMA 1 enclosure with filter for VFD's 25 HP and less.

F. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

G. Spare control-wiring terminal blocks ; wired.

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
   1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Floor-Mounting Controllers: Install VFCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
1. 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.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
1. Curbs and roof penetrations are specified in Division 07 Section "Roof Accessories."
2. Structural-steel channels are specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

G. Install fuses in each fusible-switch VFC.

H. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

I. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

J. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

K. The variable frequency drive inverter unit shall be mounted on a removable panel to facilitate maintenance.

L. New filters shall be installed into VFD units just prior to substantial completion, when system maintenance will become the owner's responsibility.

M. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, [control signal used,]and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Provide all conduit and wiring to interlock VFD with remote disconnect switches.

C. Bundle, train, and support wiring in enclosures.

D. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified third party testing agency to perform tests and inspections.

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 VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:
1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect and Owner before starting the motor(s).
5. Measure total harmonic distortion levels for voltage and current at the input terminals to the VFC. Record values for a range of frequencies: 25%, 50%, 75% and 100%.
6. Test each motor for proper phase rotation.
7. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
8. Include all measurements in the harmonic distortion report. Provide report to Engineer for review.
9. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
10. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFCs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFC and describes test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Contractor will measure and verify power quality of VFD. Deviations from minimum power quality performance specified will be remedied by the Contractor at no additional cost the Owner until power quality measurements comply with specifications.

B. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

C. Replace Filters with new at substantial completion.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect and Owner before increasing settings.

D. Set field-adjustable circuit-breaker trip ranges.

E. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 263323 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All sections of Division 01, General Requirements, apply to this section.

B. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section "General Commissioning Requirements" and Division 26 Section "Electrical Commissioning."

1.2 SUMMARY

A. Section includes the following central battery and power conversion equipment rated 600 V and less for emergency lighting:
   1. Interruptible (fast-transfer) central battery equipment.

1.3 DEFINITIONS

A. BMS: Building Management System.

B. IBC: International Building Code.

C. Interruptible: As used in the Section Text, an off-line, passive-standby or line-interactive, inverter-only unit, with an intentional interruption of power to the load until an internal transfer switch picks up and transfers the load to the unit's inverter and internal battery source on loss of the "normal" source, and then retransfers to the "normal" source when it is restored. Transfer time can be "slow" (up to approximately 1 second) or "fast" (2-4 ms or 40-50 ms, depending on manufacturer).

D. LED: Light-emitting diode.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

F. NiCad: Nickel cadmium.

G. OCPD: Overcurrent protective device.

H. PC: Personal computer.

I. PWM: Pulse-width modulated.

J. TDD: Total demand (harmonic current) distortion (also listed as "THD" in catalog data by manufacturers).

K. THD (V): Total harmonic voltage demand.

L. Uninterruptible: As used in the Section Text, an on-line, double-conversion (rectifier/inverter) unit, with no interruption of power to the load on interruption and restoration of the "normal" source.

M. UPS: Uninterruptible power supply.

N. VRLA: Valve-regulated lead acid.

1.4 SUBMITTALS

A. Provide point-by-point statement of compliance with specifications, in accordance with Section 260500.1.5B.

B. Product Data: For each type and rating of central battery equipment unit.
   1. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, shipping splits, and furnished options, specialties, and accessories.

C. Shop Drawings: For each type and rating of central battery equipment unit.
   1. Include shop drawings of electrical rooms that show spatial relationships and clearances to all electrical gear and equipment.
   2. Include plans, elevations, sections, and mounting details.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, ventilation requirements, method of field assembly, components, and location and size of each field connection.
   4. Include system one-line diagram, internal and interconnecting wiring; and diagrams for power, signal, and control wiring.
   5. Include elevation, details, and legends of control and indication displays.
   6. Include -circuit current (withstand) rating of unit.

D. Short circuit and coordination study and arc flash hazard reports prior to release for construction. Equipment is subject to change based on the results of the short circuit, coordination, and arc-flash hazard studies. Equipment submittals will not be approved until the short circuit, coordination, and arc-flash hazard studies have been approved.

E. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around central battery equipment. Show central battery equipment layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

F. Seismic Qualification Certificates: For central battery equipment, accessories, and components, from manufacturer.
   1. Certificate of compliance.
   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.

G. Product Certificates: For each type of central battery equipment.

H. Harmonic Analysis Study and Report: Provide factory prototype test report of input and output voltage and current THD levels to show that unit operates within specified limits..

I. Source quality-control reports.

J. Field quality-control reports.

K. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For central battery equipment 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. Manufacturer's written instructions for testing central battery equipment.
b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
c. Manufacturer's written instructions for selecting and setting field-adjustable controls and status and alarm points

1.6 SUBSTITUTIONS

A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 10 years' experience.

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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
   2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
   3. Humidity: More than 95 percent (condensing).
   4. Altitude: 4200 feet above sea level.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for central battery equipment, including clearances between central battery equipment and adjacent surfaces and other items.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

1.11 WARRANTY

A. Comply with the requirements outlined in Section 26 05 00, “Common Work Results for Electrical.”

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Central battery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated central battery equipment shall be tested and certified by an NRTL as meeting ICC-ES AC 156 test procedure requirements.
   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 INTERRUPTIBLE (FAST-TRANSFER) CENTRAL BATTERY EQUIPMENT

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. Hubbell Dual-Lite:

a. Trident TRF Series, Three-Phase.
b. D Series, Single-Phase.

2. Sure-Lights:
   a. Lifeway II Series, Three-Phase
   b. Lifeway II Series, Single-Phase
3. Myers Power Products:
   a. Illuminator CIII Series, Three-Phase.
   b. Illuminator IE Series, Single-Phase.
4. Perfect Power Systems
   a. PowerRide 4-Hybrid Series, Three-Phase
   b. PowerRide 1 Series, Single-Phase

B. General Requirements for Interruptible (Fast-Transfer) Central Battery Equipment:
   1. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924a.
   2. Comply with the IBC, NFPA 70, and NFPA 101.
   3. Comply with NEMA PE 1.
   4. Refer to Drawings for single-phase or three-phase unit requirements.

C. Performance Requirements:
   1. Fast-Transfer Central Battery Equipment: Passive standby (off-line) system. Automatically sense loss of normal ac supply and use a solid-state static switch to transfer load. Transfer in 40-50 ms or less from normal supply to battery-inverter supply.
   2. Automatic Operation:
      a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, bypassing inverter, with battery connected in parallel via rectifier/charger output.
      b. Abnormal Supply Conditions: If normal ac supply deviates from specified voltage, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
      c. If normal power fails, solid state static transfer switch conducts and batteries supply DC power to inverter and inverter supplies regulated AC power to the load with a momentary loss of power to the load.
      d. If a fault occurs in system when being supplied by inverter and current flows in excess of the overload rating of inverter, inverter automatically protects itself against damage from overloads and short circuits by shutting down.
      e. When normal ac power is restored at input supply terminals of unit, the solid-state static transfer switch stops conducting and the controls automatically retransfer the load back to the normal ac supply, with a momentary loss of power to the load. Rectifier/charger then recharges battery.
      f. If normal power failure is prolonged (more than 90 minutes), integral low-voltage battery protective circuit disconnects battery and prevents battery from damage due to deep discharge.
      g. If battery becomes discharged, and when normal ac supply is again available, rectifier/charger recharges battery. When battery is fully charged, rectifier/charger automatically shifts to float-charge mode.

h. If battery is disconnected, and normal ac power is available, central battery equipment continues to supply normal power to the load with no degradation of its regulation of voltage and frequency of output bus.

D. Unit Operating Requirements:
1. Capable of taking the full starting load of lighting during transfer to battery supply and re-transfer to normal supply.
2. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.
3. Input Frequency Tolerance: Plus or minus 3 percent of central battery equipment frequency rating.
4. Synchronizing Slew Rate: 1 Hz per second, maximum.
5. Minimum Off-Line Efficiency: 99 percent at 60 Hz, full load.
6. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or operating condition.
7. Ambient Temperature Rating (Other Than Batteries): Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
8. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F (minus 20 deg C) and not exceeding 158 deg F (70 deg C.)
9. Ambient Temperature Rating (Batteries): Not less than 68 deg F (20 deg C) and not exceeding 86 deg F (30 deg C).
10. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C.)
11. Humidity Rating: Less than 95 percent (noncondensing).
12. Altitude Rating: 4200 feet above sea level.
13. Off-Line Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

E. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.

F. Controls and Indication:
1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:
a. Normal power available.
b. Status of system.
c. Battery charging status.
d. On battery power.
e. System fault.
f. External fault.
2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
a. Keypad: In addition to required programming and control keys, include the following:
1) Keys for METER, CONTROL, PROGRAM, and CLEAR modes.
2) Security Access: Provide electronic security access to controls through identification and password with at least two levels of access: View only; and view, operate, and service.

3) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.

b. Digital Display: Plain-English language messages on a digital display; provide the following historical logging information and displays:
   1) Real-time clock with current time and date.
   2) Tests and Events Logs: Record and store up to 25 tests and events.
      a) Dates.
      b) Times.
      c) Durations.
      d) Output voltage and currents.
   3) Alarm Logs: Record and store up to 25 alarms.
      a) Dates.
      b) Times.
      c) Alarm type.
   4) Metering Functions: Display central battery equipment metering parameters including, but not limited to, the following:
      a) Input and output voltage (V ac) and output current (A ac).
      b) Battery voltage (V dc) and current (A dc).
      c) Fault or alarming status (code).
      d) Power output (VA).
      e) Inverter load (W).
      f) Ambient temperature (deg F).
      g) System run time (cumulative days).
      h) Inverter run time (cumulative minutes).
   5) Alarm Functions: Digital display mounted flush in unit door and connected to display central battery equipment parameters including, but not limited to, the following:
      a) High/low battery charge voltage.
      b) High/low input voltage.
      c) Battery nearing low-voltage condition.
      d) Battery low voltage.
      e) High ambient temperature.
      f) Inverter fault.
      g) Output fault.
      h) Output overload.

3. Remote Signal Interfaces:
   a. Remote Indication Interface: A minimum of one programmable (Form C) dry-circuit relay output(s) (120-V ac, 2 A) for remote indication of the following:
      1) Normal status.
      2) Fault or status indication.
      3) On bypass.
      4) Low battery.

b. Send trouble alarm to Building Management System (BMS) if any of the alarm functions in section 263323.11-2.2(F)(2)(b)(5) are triggered.
c. Communications Interface: Factory-installed hardware and software to enable a remote PC to program central battery equipment and monitor and display status and alarms.
   1) Communications Ports:
      a) RS-232 and RS-485
      b) Provisions for communicating with BMS via Bacnet protocol. Coordinate with Div 23 for further details.

   2) Network Communications Ports: Ethernet , RS-232, and RS-485.
   3) Provide a CAT5 or CAT6 or USB port on front for plugging in a laptop PC for programming or testing.
   4) Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications, and shall be able to communicate directly via BMS RS-485 serial networks and Ethernet 10Base-T networks as a native device.

G. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
   2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.
   3. Battery deep-discharge and self-discharge protection; with alarms.
   4. Battery self-test circuitry; with alarms and logging.

H. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489.
   1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating:
      a. 65kAIC fully rated, unless otherwise indicated by the short circuit and fault current study.

I. Inverter:
   1. Description: Solid-state, high-frequency, PWM type, with the following operational features:
      a. Automatically regulate output voltage to within plus or minus 5 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes.
      b. Automatically regulate output frequency to within plus or minus 3 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
      c. Output Voltage Waveform: Sine wave with maximum 5 percent TDD throughout battery operating-voltage range, for 100 percent linear load.
      d. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.
      e. Load Power Factor: 0.5 lead to 0.5 lag.
      f. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

J. Rectifier/Battery Charger:

1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.
2. Maximum Battery Recharge Time from Fully Discharged State: 12 hours.
3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.
4. Input current total harmonic distortion (THD) shall be less than 3% at 100% loading and 5% at 50% loading.
5.

K. Batteries:
   1. Description: Sealed, lithium-ion batteries. Submit description of batteries with Submittals.
      a. Capable of sustaining full-capacity output of inverter unit for not less than 90 minutes.
   2. Battery Disconnect and OCPD: Manufacturer's standard.
   3. Battery expected life: 20 years, 17,000 discharges
   4. Battery Warranty: 10 years.
   5. Acceptable Manufacturers:
      a. Toshiba
      b. Samsung

L. Maintenance Bypass Systems:
   1. Maintenance Bypass Mode: Internal; manual operation only; bypasses central battery equipment power circuits (inverter and static transfer switch); requires local operator selection at central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load. Operating the switch shall be strictly restricted to authorized personnel with cabinet access key. The maintenance bypass shall be operated in conjunction with a S-1 synchronization switch, ensuring full synchronization and no inrush current during transfer.
   2. Bypass Overload Capability: 1.15 times the base load current.

M. Integral Output Disconnecting Means and OCPD:
   1. Multiple-Output OCPDs: Thermal-magnetic circuit breakers, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.
      a. Normally Closed: As scheduled on Drawings with trip alarm.
      b. Normally Open: As scheduled on Drawings with trip alarm.

N. External Manual Maintenance Bypass Switch: An auto/manual MBS switch shall be provided external to the UPS cabinet/system to enable complete de-energization of incoming power to the UPS for maintenance and servicing purposes, without disrupting power to the critical load the UPS system serves. The switch shall be strictly restricted to authorized qualified personnel with cabinet access key. The MBS shall be operated in conjunction with an S-1 synchronization switch, ensuring full synchronization and no inrush current during transfer.

2.3 ENCLOSURES

A. Central Battery Equipment Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
   2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.4 OPTIONAL AND ACCESSORY FEATURES

A. Factory-Installed Options and Accessories:
   1. Multiple-Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.
   2. Split-Output Configuration: Divides output into normally on and normally off buses.
   3. Auto-dialer.
   4. Internal fax modem.
   5. Audible alarm with silencer switch.
   6. Remote Summary Alarm Panel: Labeled LEDs on panel faceplate shall indicate five basic status conditions. Audible signal indicates alarm conditions; silencing switch in face of panel silences signal without altering visual indication.
      a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
      b. Maximum Distance from Main Unit: 1000 feet.
   7. Remote Meter Panel: Match equipment requirements of remote monitoring, controlling, and programming of central battery equipment.
      a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
      b. Maximum Distance from Main Unit: 150 feet.

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect central battery equipment according to UL 924a.

B. Factory Tests: Test and inspect assembled central battery equipment by a qualified testing agency according to UL 924a and NFPA. Affix standards organization's label. Include the following:
   1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
   2. Full-load test.
   3. Transient-load response test.
   4. Overload test.
   5. Power failure test.

C. Central battery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store central battery equipment according to NECA 411.

B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, 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 will be installed, before installation begins.

C. Examine equipment before installation. Reject equipment that is wet, moisture damaged, or mold damaged.

D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install central battery equipment and accessories according to NECA 411.

C. Wall-Mounted Central Battery Equipment: Install central battery equipment on walls with tops at uniform height and with disconnect operating handles no higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For units not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

D. Floor-Mounted Central Battery Equipment: Install central battery equipment on concrete base. Comply with requirements for concrete base specified in Section 260529 “Hanger and Supports for Electrical Systems” and Section 033000 "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

E. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

G. Comply with NECA 1.

H. Wiring Method: Install cables in raceways except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
1. Provide spade type lugs for incoming/outgoing wires.
2. Tag interior wiring with slip-on type plastic sleeve, black print on white.
3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

3.3 CONNECTIONS

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between central battery equipment and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Cables."

B. Bundle, train, and support wiring in enclosures.

3.5 IDENTIFICATION

A. Identify central battery equipment, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label central battery equipment with engraved nameplates.

3. Label each separate cabinet, for multi-cabinet units.
4. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for central battery equipment, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of central battery equipment units.

3.6 FIELD QUALITY CONTROL

A. 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.

B. Acceptance Testing Preparation:
1. Inspect and Test Each Component:
a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
b. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
c. Test continuity of each circuit.

C. Tests and Inspections:
1. Inspect central battery equipment, wiring, components, connections, and equipment installation.
2. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
3. Test continuity of each circuit.
4. Verify that input voltages and frequencies at central battery equipment locations are within voltage and frequency limits specified in Part 2. If outside this range, notify Construction Manager before closing input OCPDs.
5. Perform each visual and mechanical inspection and electrical test stated in manufacturer's written instructions and in NETA Acceptance Testing Specification, including specifically those for batteries, battery chargers, and UPS, regardless of the type of central battery equipment provided. Certify compliance with test parameters.
6. Perform a load-duration test at rated voltage and rated output current to verify the correct functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) 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 central battery equipment. 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 central battery equipment 11 months after date of Substantial Completion.
c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Central battery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, and other adjustable parts.

C. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous-trip elements; install fuses if not factory installed.

D. Set the automatic system test parameters.

E. Set field-adjustable, circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace central battery equipment whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.
   1. Training shall consist of a single 4-hour session.
   2. Training shall be hands on and include adjustment, operation, and maintenance for the equipment.
   3. Training shall include a question and answer session.
   4. Training shall be video recorded. Three electronic copies of the training (in .AVI format) shall be provided within the O&M manual submittal.

B. The Contractor and/or the Systems Manufacturer's representatives shall provide a typewritten "Sequence of Operation" written for this facility.

3.11 OWNER'S QUALITY ASSURANCE

A. Owner's independent commissioning and witnessing agency will provide the following witnessing and/or review services:
   1. Review factory test reports.
   2. Review all test reports.
   3. Witness battery testing.
   4. Witness operational tests.
   5. Witness BMS interface tests.

END OF SECTION 263323

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes lightning protection for structures and structure elements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For air terminals and mounting accessories.

1. Contractor shall prepare and provide the deferred submittal design for lightning protection system per NFPA 780.
2. Layout of the lightning protection system, along with details of the components to be used in the installation.
3. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

C. Field quality-control reports.

D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Ground loop conductor.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.

B. System Certificate:
   1. LPI Limited Scope System Certificate, certification applies to new structure only.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96, UL 96A, and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum or copper unless otherwise indicated.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. East Coast Lightning Equipment Inc.
      b. ERICO International Corporation.
      c. Harger.
      d. Heary Bros. Lightning Protection Co. Inc.
      e. Independent Protection Co.
      f. Preferred Lightning Protection.
      g. Robbins Lightning, Inc.
      h. Thompson Lightning Protection, Inc.
      i. VFC

   2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.

3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.

C. Main and Bonding Conductors: Copper.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel or Solid copper.

G. Fastening System: Utilize Z-Pen fastening system with architectural adhesives without penetrations or construction mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.

D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.

F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

G. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

H. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

1. Bury ground ring not less than 24 inches (600 mm) from building foundation.
2. Bond ground terminals to the ground loop.
3. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.

I. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. LPI System Inspection: Meet requirements to obtain an LPI Limited Scope System Certificate for the new structure.

END OF SECTION 264113

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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 field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:
   1. Section 26 2413 "Switchboards" for factory-installed SPDs.
   2. Section 26 2416 "Panelboards" for factory-installed SPDs.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

C. Comply with NEMA LS 1.

D. Comply with UL 1283 and UL 1449, 3rd Edition.

E. Comply with NFPA 70.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE AND MAIN FEEDER SUPPRESSOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Current Technology Inc.; Danaher Power Solutions.
2. Eaton Corporation.
3. Emerson Electric Co.
4. GE Zenith Controls.
5. LEA International; Protection Technology Group.
6. Schneider Electric Industries SAS.
7. Siemens Industry, Inc.

B. SPDs: Comply with UL 1449, Type 1.

1. SPDs with the following features and accessories:
   a. Integral disconnect switch.
   b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
   c. Indicator light display for protection status.
   d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
   e. Surge counter.
2. Integral to service entrance equipment, factory installed. Device shall be installed in a separate compartment within the equipment that completely isolates the device upon failure to eliminate the spread of smoke within the service entrance equipment.
3. Separate enclosure for field installation outside of the service entrance equipment.

C. Comply with UL 1283.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 240kA. 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 circuits with 480Y/277 V or 208Y/120 V, 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. SCCR: Equal or exceed 100 kA.

G. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Current Technology Inc.; Danaher Power Solutions.
2. Eaton Corporation.
3. Emerson Electric Co.
4. GE Zenith Controls.
5. LEA International; Protection Technology Group.
6. Schneider Electric Industries SAS.
7. Siemens Industry, Inc.

B. SPDs: Comply with UL 1449, Type 1.
1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
4. Integral to service entrance equipment, factory installed. Device shall be installed in a separate compartment within the equipment that

completely isolates the device upon failure to eliminate the spread of smoke within the service entrance equipment.

5. Separate enclosure for field installation outside of the service entrance equipment.

C. 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.

D. Comply with UL 1283.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, 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. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

G. SCCR: Equal or exceed 100 kA.

H. Inominal Rating: 20 kA.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:
   1. Power Wiring: Comply with wiring methods in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
   2. Controls: Comply with wiring methods in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
   1. Compare equipment nameplate data for compliance with Drawings and Specifications.
   2. Inspect anchorage, alignment, grounding, and clearances.
   3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

SECTION 265100 - INTERIOR LIGHTING

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. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:
1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 260936 "Modular Dimming Controls" for architectural dimming systems.
3. Section 260943.13 "Addressable-Fixture Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
4. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.
1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.

3. Ballast, including BF.
4. Energy-efficiency data.
5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Action Submittals" Article in Section 233713 "Diffusers, Registers, and Grilles."
6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Section 233713 "Diffusers, Registers, and Grilles."
7. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
8. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
    a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
    b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. If project is LEED Certified or to be LEED Certified, product data submittals shall also include the following information and highlighted in submittal:
    1. Luminance Chart/Graph showing fixture utilizes less than 7500 cd/m^2 between 45 and 90 degree from nadir.
        a. Exceptions include wall wash and indirect only type fixtures.
    2. Unified glare rating
    3. CRI of 80 or higher
        a. Exceptions include site lighting, accent or colored lighting
    4. Rated life, L70, of at least 24,000 hours

C. Finish and Color Submittal: Provide a complete finish and color submittal package with all finish and color options for each fixture available for the project. Architect shall provide selections based on this separate submittal.

D. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
    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. Wiring Diagrams: For power, signal, and control wiring.

E. Seismic Qualification Certificates: For lighting fixtures, 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.

F. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:
   1. Lamps and ballasts, installed.
   2. Cords and plugs.
   3. Pendant support system.

G. Installation instructions.

1.5 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. Lighting fixtures.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
   4. Ceiling-mounted projectors.
   5. Structural members to which suspension systems for lighting fixtures will be attached.
   6. Other items in finished ceiling including the following:
      a. Air outlets and inlets.
      b. Speakers.
      c. Sprinklers.
      d. Smoke and fire detectors.
      e. Occupancy sensors.
      f. Access panels.
   7. Perimeter moldings.

B. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

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. Fixtures/Lamps: 5 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

3. LED-fixture-mounted, emergency battery pack: One for every 20 emergency lighting unit.
4. Drivers: One for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

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 NFPA 70.

D. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

E. Mockups: Provide interior lighting fixtures for room or module mockups complete with power and control connections.
1. Obtain Architect's approval of fixtures for mockups before starting installations.
    a. All Pendant lighting shall be mocked up in the space with an individual fixture and approval of suspension height from architect prior to any other similar installation.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Warranty Period for Emergency Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

3. Acrylic Lenses, Anti-Yellowing: 5 years from date of Substantial Completion if acrylic lenses have any noticeable sign of yellowing.
4. Warranty Period for LED Luminaires: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining 4 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Diffusers and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
   b. UV stabilized.
2. Glass: Annealed crystal glass unless otherwise indicated.

I. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
   a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
f. CCT and CRI for all luminaires.

2.

2.3 LED LAMPS AND DRIVERS

A. Approved Manufacturers for Luminaires shall be as scheduled.

B. Approved Manufacturers- LEDs
1. General Electric
2. Philips
3. Osram
4. Cree
5. Xicato
6. Nichia

C. Approved Manufacturers- Drivers
1. General Electric.
2. Philips.
3. Osram / Sylvania.
4. Lutron
5. EldoLED
6. Thomas Research

D. Lumen output shall be Luminaire Lumens or Delivered Lumens. Source lumens shall not be used, per IES LM-79 and LM-80.

E. Inrush current shall be negligible. Maximum allowed is 30mAs.

F. THD: THD shall not exceed 20% at full load.

G. Minimum driver efficiency shall be 86% at 65% rated load.

H. Maximum off-state power consumption 0.5w.

I. Compliant with FCC 47 CFR Part 15 A for Residential applications and B for Commercial applications.

J. Luminaire shall be NRTL Listed at intended operating temperature.

K. Photometry shall be measured or absolute photometry. Derived or calculated photometry shall not be provided for consideration.

L. Drivers for Solid State Lighting Sources: Comply with UL 8750 and be so recognized.

M. Ballast Circuit: Constant-current or constant voltage as required by the LED assembly.

N. High power factor >.90

O. Driver and Led modules shall operate the solid state light source in a constant manner, performing without measurable flicker below 25kHz along entire range of dimming.

P. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).

Q. Rated and UL / ETL tested ambient operating temperature:104 deg F (40 deg C).

R. CRI (Ra) shall be based on CIE/IES definition using 8 color criteria. Comply with R9 value, if specified. Minimum CRI Ra- 82 or as specified.

S. Individual LEDs shall be tested in compliance with IES LM-79-08. The complete LM-79 report shall be available if requested.

T. Chromaticity tolerance shall be 2 MacAdam ellipses for interior applications and 6 MacAdam Ellipses for exterior applications. Rating shall be by ANSI/NEMA C78.377-2008.

U. Rated life shall be as determined by IES LM-80-08 and IES TM-21-11. These full reports shall be available if requested.

V. Only original Absolute Photometry in compliance with IES LM-79-08 shall be used to report solid state luminaire performance. Derived files are not acceptable.

W. Do not exceed scheduled drive current. Open-circuit operation that will not reduce driver life.

X. Dimming by DMX, DALI, PWM or CCR methods are approved, must be compatible with the control systems on the projects. Dimming range shall be from 100% to 1% of measured light output.

Y. Dimming drivers shall be compatible with the control method shown on the drawings. All dimmed drivers shall use 0-10vdc control unless specified differently. Minimum level shall be 1% or as scheduled.

Z. Low-Noise Ballasts: manufacturers' standard epoxy-encapsulated or noise suppressed modules designed to minimize audible fixture noise.

AA. LED modules and drivers shall be replaceable in the field, LED modules shall have digitally traceable matching modules.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
   2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal

voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

3. Master/Remote Sign Configurations:
   a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply battery for power connection to remote unit.
   b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.5 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
   1. Battery: Sealed, maintenance-free, lead-acid type.
   2. Charger: Fully automatic, solid-state type with sealed transfer relay.
   3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
   7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
   8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
   9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:
1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from at least two diagonal corners of lighting fixture and attach to building structure.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
   4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
   5. Safety Cables: to prevent the fixture from falling if swaying breaks the pendant.

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

B. Related Sections:
1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. Pole: Luminaire support structure, including tower used for large area illumination.

G. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s) with a 1.3 gust factor, and minimum design life of 30 years.

1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Details of attaching luminaires and accessories.
   3. Details of installation and construction.
   4. Luminaire materials.
   5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
      a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   6. Ballasts, including energy-efficiency data.
   7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
   8. Materials, dimensions, and finishes of poles.
   9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
   10. Anchor bolts for poles.
   11. Manufactured pole foundations.

B. Finish and Color Submittal: Provide a complete finish and color submittal package with all finish and color options for each fixture available for the project. Architect shall provide selections based on this separate submittal.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   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. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
   3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
   4. Wiring Diagrams: For power, signal, and control wiring.

D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

E. Pole bases: Provide deferred submittal of pole base design signed and stamped by a structural engineer licensed in the state of Utah based on the project conditions and submitted pole and light combination.

F. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

G. Field quality-control reports.

H. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

I. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

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 IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
   1. Warranty Period for Luminaires including LED's: Five years from date of Substantial Completion.
   2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
   3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
   4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's

standard warranty period, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: One for every 10 of each type and rating installed. Furnish at least one of each type.
   2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 20 of each type and rating installed. Furnish at least one of each type.
   3. Ballasts: One for every 10 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
   1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
   2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
   3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    a. Color: As selected by Architect from manufacturer's full range.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
    a. Color: As selected by Architect from manufacturer's full range.

O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:

a. "USES ONLY" and include specific lamp type.
b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
f. CCT and CRI for all luminaires.

P. Exterior Lighting Fusing:
1. Manufacturer:
a. Cooper Bussman.
1) Type: KTK-6, 6A 600V.
2) Fuse Holder: HEB-JJ in-line with rubber insulating boots.
3) Note: Crimp style fuses shall not be allowed.
2. Each fixture shall have fusing inside of hinged pole base.
3. Fusing shall be provided for each ungrounded conductor.

2.3 LED LAMPS AND DRIVERS:

A. Minimum CRI Ra- 82 or as specified.

B. Lumen output shall be Luminaire Lumens or Delivered Lumens. Source lumens shall not be used, per IES LM-79 and LM-80.

C. Color Consistency 3 MacAdams Ellipse or better.

D. LED Rated life L70 of 50,000 hours per (IES TM-21). Luminaire shall maintain LED operating temperature to achieve this rating per TM-21.

E. Flicker: No visible or detectable flicker, operating on all dimmed intensities.

F. Dimming drivers shall be compatible with the control method shown on the drawings. All dimmed drivers shall use 0-10vdc control unless specified differently. Minimum level shall be 1% or as scheduled.

G. Inrush current shall be negligible. Maximum allowed is 30mAs.

H. THD: THD shall not exceed 10% at full load.

I. Minimum driver efficiency shall be 86% at 65% rated load.

J. Maximum off-state power consumption 0.5w.

K. Compliant with FCC 47 CFR Part 15 A for Residential applications and B for Commercial applications.

L. LED module shall be replaceable in the field using modules with digitally traceable matching modules.

M. Luminaire shall be NRTL Listed at intended operating temperature.

N. Photometry shall be measured or absolute photometry. Derived or calculated photometry shall not be provided for consideration.

O. Approved Manufacturers- Drivers
1. General Electric.
2. Philips.
3. Osram / Sylvania.
4. Lutron
5. EldoLED
6. Thomas Research

P. Approved Manufacturers- LEDs
1. General Electric
2. Philips
3. Osram
4. Cree
5. Xicato
6. Nichia

2.4 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

G. Hinged Bases:
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
   a. Sterner Lighting; Hubble Lighting.
   b. LSI Industries, inc.
2. The folding direction of hinged base shall allow for a full 90 degree tilt.

2.5 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
1. Shape: As indicated.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
3. Hinged pole base assembly where indicated.

B. Steel Mast Arms: configurations and types indicated, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

G. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   a. Color: As selected by Architect from manufacturer's full range.

2.6 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
   1. Shape: as indicated.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as pole and luminaire.

E. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
      a. Color: As selected by Architect from manufacturer's full range.

2.7 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

D. [Where existing pole lights are specified to be removed and/or relocated, the Contractor shall replace lost or damaged lights and/or poles with new equipment at no additional cost to the Owner].

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
   3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
   4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

G. Hinged Pole Bases:
   1. Install hinged pole base on each pole light.

H. Hinge direction shall not be directed onto a slope or into traffic.

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 2-3 inches (50 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base with a 2-3 inch reveal around bollard. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
   3. Copper-clad ground rods shall not be installed under concrete pole base.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265600

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SECTION 274100 - 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."

1.6 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

1.7 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.

1.8 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.

1.9 SUBMITTALS

A. Submit in accordance with Sections 013300, Submittal Procedures 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 as dictated in 013300 and 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 "Approved," 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 "Approved as Noted," 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 "Not Approved, 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".

1.10 SUBSTITUTIONS

A.Substitution Request Submittal: Requests for substitution may be considered or rejected at the discretion of the Architect, Engineer, Designer, and/or Owner. In addition to the below requirements, comply with Substitution Procedures Section 012500. As specified in Special Project Note #1, substitution requests to change equipment items from those identified in the Acceptable Types column in the Audio-Video Equipment List found in the accompanying drawings must be completed prior to bidding in compliance with the bidding schedule set forth by the project General Contractor.

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.

1.11 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.

1.12 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.

1.13 WARRANTY REQUIREMENTS

A. Reference Section 017800, 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 of 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.

1.14 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.

1.15 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 in the new building, or any other location 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.

A. 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 week (5 business days) of building occupancy from 7:00 a.m. to 4:00 p.m. 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.

B. 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 ten (10) occupancy adjustment trips to the site in the base bid for this project.

END OF SECTION 274100

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SECTION 274101 - 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 dully authorized representative of the manufacturer of technology systems equipment.

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.

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.

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 incompletion, 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 274101

SECTION 274102 - 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 section 27 41 00 for definition 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 restrain requirements shall be computed as the ½ 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 274102

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SECTION 274113 - AUDIO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The audio system will provide for voice amplification and media device audio program amplification. Media device audio program and voice audio amplification will originate from various media sources and microphones, be switched through a source selection switcher, and/or be mixed, processed and amplified to the speaker system. In addition provide multi-channel audio routing between all processors.

B. This Section includes requirements for audio system components including, but not limited to, the following:
   1. Microphones
   2. Mixers
   3. Power Amplifiers
   4. Cabinets
   5. Racks
   6. Loudspeaker Systems
   7. Microphone Inputs
   8. Processors
   9. Combiners
   10. Source Devices
   11. Digital Signal Processors
   12. Wire, Cable, and Connectors

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections: The following Division 27 sections contain requirements that relate to this section:
   1. General Technology Systems Requirements
   2. Basic Technology Systems Requirements
   3. Basic Technology Systems Materials and Methods

C. Related Sections: Several sections of Division 26 contain requirements that relate to this section.

1.3 SYSTEM DESCRIPTION

A. General: The audio systems shall be complete systems for amplifying sound signals from microphones and media source equipment and distributing them to loudspeakers at various locations.

B. Functional Performance: Components and system features and functions shall include, but are not limited to, the following:

1. Meet the following performance parameters as measured in 1/3 octave bands:
   a. From 75 Hz to 2kHz, flat within plus or minus 2dB.
   b. Above 2kHz, slope down along an approximate 3dB octave slope to 8kHz.
2. Sound pressure levels at 2kHz octave band shall not deviate more than plus or minus 2dB.
3. When driven to maximum output, clipping shall first occur in power amplifiers.
4. No noise, hum, RFI pickup or distortion shall be audible under normal operating conditions.
5. Sound system shall reproduce program material at a level of 100 dBa without audible distortion.

1.4 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:
1. Product data for each type of product specified.
2. Shop drawings detailing audio system including, but not limited to the following:
   a. Connection panels.
   b. Rack elevations showing component arrangement inside equipment racks.
   c. Complete layouts of all DSP devices. Including but not limited to audio routing, control, logic, level control, etc...
3. Wiring Diagrams detailing wiring for power, signal, and control. Provide actual hook-up drawings showing the connection point of each conductor. Single line drawings will not be accepted. Include all cable labeling on wiring diagrams. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.
4. Maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 27 Section "Basic A/V System Requirements." Provide complete operations and maintenance manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover. Include the following:
   a. Equipment list showing quantity, make, model, and serial number.
   b. System operating instructions.
   c. System maintenance instructions.
5. Proposed DSP configuration showing individual processor blocks with block resources identified, and signal flow.
6. Wiring codes for all system cable. (See "labeling", this section).
7. Proposed labeling for system components. (See "labeling", this section).
8. All special submittal instructions indicated on supplied design drawings.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of sound system, components and accessories, of types, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience of A/V system projects similar to that required for this project. In addition, installers must have successfully completed a minimum of 3 similar installations over a period of 2 years prior to the date of the bid opening for this project. System installations must have included similar automatic mixers, matrices, and digital signal processors. To qualify as similar, audio systems must have included complete installation, set up, programming, balancing, and equalization of automatic mixers, matrix routers, and digital signal processors. All such installation, set up, programming, balancing, and equalization work must have been completed by a factory trained and certified technician of the specified mixer, matrix, and digital audio processor manufacturer. The certified technician must have successfully completed all relevant training courses recommended by the manufacturers of the above referenced equipment for proficiency in these skill sets. In addition, the certified technician must have been, and now be, a direct employee of the installer, in a permanent office staffed with factory qualified technicians, working for a minimum of 40 hours per week as a direct employee of the installer. The certified technician and factory trained installers must be the direct employees of the installer; sub-contracted, third party maintenance agreements, or similar arrangements are expressly prohibited, and do not qualify. Upon request, submit evidence of such qualifications to the Designer/Engineer. All of the above requirements must be complied with prior to the bid opening for this project.

C. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."

D. EIA Compliance: Comply with the following Technology Industries Association Standards:
   1. Sound Systems, EIA-160.
   2. Loudspeaker, Dynamic Magnetic Structures, and Impedance, EIA-299-A.
   3. Racks, Panels, and Associated Equipment, EIA-310-A.
   4. Amplifiers for Sound Equipment, SE-101-A.
   5. Speakers for Sound Equipment, SE-103.
   6. Microphones for Sound Equipment, SE-105.

E. UL Compliance: Comply with requirements of UL 50.

F. All installation practices shall be in accordance with, but not limited to, these specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements, and recommendations of the Uniform Building Code, the National Electrical Code and all local authorities having jurisdiction. All installation work shall follow "standard broadcast wiring" and installation practices, as excerpted from "Recommended Wiring Practices," Sound System Engineering, (2nd Edition), D. Davis, and performed to the highest standards of acknowledged industry practices.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

1.7 WARRANTY REQUIREMENTS

A. Audio system shall be subject to warranty requirements as stated in section 27 41 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by those manufacturers identified in the equipment list. Firms regularly engaged in manufacture of sound system components and accessories, of types, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. All equipment and material shall be new, and must have been commercially available for at least one year prior to bid.

C. All equipment must be UL listed or built to UL standards.

2.2 SYSTEM REQUIREMENTS

A. General: Provide complete and fully functional audio systems using materials and equipment of types, sizes, ratings, and performances as indicated in the equipment list in the accompanying drawings. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction in accordance with published product information. Coordinate the features of materials and equipment so they form an integrated system with components and interconnections matched for optimum performance of specified functions.

B. Provide all wire, cable, and connectors as required to complete the installation of all systems as designed and specified.

2.3 EQUIPMENT AND MATERIALS

A. General: Provide equipment selected from equipment list on drawings, or as substituted following the proscribed substitution process, using all solid-state components fully rated for continuous duty at the ratings indicated or specified. Select equipment for normal operation on input power supplied at 105-130 V, 60 Hz.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with requirements and other conditions affecting the performance of the Audio System work.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three times the weight of the equipment being installed. Any structural mounting that is not able to meet this requirement due to the specific nature of the equipment, manufacturer's requirements or limitations of the facility, shall not be installed without prior approval of the Engineer. Install all boxes, equipment, hardware, and other materials plumb, level, and square.

C. Install all technology equipment and support equipment in podium, and the other millwork in a neat and cosmetically dressed-out manner. All saw cuts, holes and recesses into laminates and woodwork shall be straight, all radius and circular cuts shall be consistent, and all uneven surfaces shall be corrected. This shall include the use of moldings, grommets, bushings, laminates, and wood products as required to dress out the installation of equipment. Assure that the installation of equipment and panels in the technology racks and podiums are completed by using matching screws, hardware and grommets.

D. Speakers:
   1. Confirm polarity of speaker before installation and wire to maintain uniform polarity.
   2. Mount transformers with screws securely to speaker brackets or enclosures.
   3. Neatly mount speaker grilles, panels, connector plates, control panels, etc., tight, plumb, and square unless indicated otherwise on drawings.
   4. Provide brackets, screws, adapters, springs, rack mounting kits, etc., recommended by manufacturer for correct assembly and installation of speaker assemblies and technology components.
   5. Make speaker cable connections with rosin core solder or wire nut or equivalent connections.
   6. Loosely but completely fill speaker back boxes that do not have fiberglass installed with fiberglass.
   7. Seal cone speakers to backbox so air will not pass from one side of speaker to another.
   8. Securely mount speaker systems to custom wall mount brackets. Comply with applicable seismic codes and requirements.

E. Technology:
   1. Assure sufficient ventilation for adequate cooling of equipment.
   2. Mount amplifiers at top of equipment cabinet. Install vent rack panels in unused spaces. Install vent panels at top and bottom and above each power amplifier.
   3. Securely fasten equipment plumb and square in place. Where equipment is installed in rack cabinets, utilize all fastening holes and cover open spaces with perforated panels.

4. Securely fasten relays and small components. Do not use sticky-back tape for fasteners.
5. Install balancing transformer on each unbalanced input or output that connects to device outside equipment cabinet, or that connects to balanced input or output within equipment cabinet.
6. Connect powered components to 120 VAC outlets on transient voltage surge suppressors. Do not connect to outlets on other components.
7. Leave sufficient service loops of uniform length on cables to allow operation of system with chassis outside cabinet.
8. All equipment shall be held firmly in place with proper types of mounting hardware as recommended and/or supplied by the manufacturer. All mounting hardware provided with equipment shall be used when practical. This shall include, but not be limited to, front and rear rack rails, angle brackets and rack mount kits. All equipment shall be installed so as to provide reasonable safety to the operator.

F. Cable, Wire, and Connectors:
1. All cable and wire shall be new and unspliced. Splicing of cables and conductors is expressly prohibited in any location other than the equipment racks. Splicing of audio and video cables will not be allowed in any location. Splicing of control conductors shall be accomplished via punch block or terminal strip connections only.
2. Additional cable length shall be provided at all connector locations. Duplex box, junction box, and floor box locations shall be installed with sufficient cable length behind cover plates to permit wiring maintenance and connector replacement in the future.
3. When cable runs utilize the vertical cable raceways located within walls, the acoustic integrity of the walls shall be maintained. All cables that pass through cover plates of junction boxes and raceways, through slab-to-slab walls, and through conduit lines shall be properly gasketted and sealed and all acoustic material shall be restored or replaced.
4. Separation between system cables and all other services shall be maximized to prevent and/or minimize the potential for electro-magnetic interference (EMI). Particular care shall be taken to ensure at least a 12" separation from electrical lines whenever feasible. At points where separation is unavoidable, distribution cables shall cross other services at right angles whenever practical to minimize EMI.
5. Cables shall be installed in a manner that shall ensure no signal cables are placed on top of any lighting fixtures, ceiling speakers, video projector lifts, projection screens, HVAC controls or sensing devices, fire safety and sprinkler system detection technology, or any other technology or mechanical equipment.
6. No cables shall be laid directly on top of T-bar grid ceiling tiles. Support cables installed outside of conduit at a maximum of four foot intervals from the building structure. Do not utilize support wires from other trades or systems.
7. System cables shall be installed in a manner that will not block access to other equipment or services, across removable service panels and/or in any other manner to prohibit routine maintenance of HVAC systems, fire safety equipment and building mechanical control systems.
8. All exposed conductors inside of equipment racks shall be dressed with heavy duty neoprene heat-shrink tubing.
9. All inter-rack cabling shall be neatly laced, dressed, strain relieved and adequately supported.

10. After completion of wiring and cable installation, all trough and box covers shall be notched out and grommetted for clearance of the various cable bundles, (i.e., separate audio, video, and control). These panel covers shall be screwed back in place and all gaskets shall be restored or replaced.
11. Do not place any wires and cables for this system in any conduit, raceway, wire way or cable tray that is used for the mechanical systems of the building.
12. Provide connectors of the type and quality as detailed in this contract, and/or as required to meet the minimum bandwidth requirements of the equipment to which the connectors are terminated. The overall quantity of connectors shall not be limited by the quantities indicated in the drawings and shall be provided as required.
13. No connectors shall be installed in non-accessible locations or used for splicing cables. All connectors shall be new.
14. All connectors shall incorporate strain relief mechanisms which firmly grip the jacket of connected cables. All connectors shall be properly polarized to prevent improper seating. Connectors shall provide appropriate electrical characteristics for the circuitry to which they are attached.
15. All inner-rack cables shall be grouped according to the signals being carried to reduce signal contamination. Separate groups shall be formed for the following:
    a. Power
    b. Control
    c. Video
    d. Audio cables carrying signals less than -20 dBM.
    e. Audio cables carrying signals between -20 dBM and +20 dBM.
    f. Audio cables carrying signals over +20 dBM.
16. Route all cable and wiring within equipment racks, cabinets and millwork according to function, separating wires of different signal levels (microphone, line level, amplifier output, AC, control, etc.) by as much distance as possible. Neatly arrange, harness and bundle all cable with nylon U/V rated ties.
17. As a general practice, all power cables, control cables, and high level cables shall be run on the left side of equipment racks as viewed from the rear. All other cables shall be run on the right side of all equipment racks as viewed from the rear.
18. All cables, except video cables which must be cut to an electrical length, shall be cut to the length dictated by the cable run.
19. Terminal blocks, boards, strips or connectors, shall be furnished by the installer for all cables which interface with racks, cabinets, consoles, or equipment modules. Affix terminal blocks, boards, strips or connectors to equipment racks using screws only. Double sided tape will not be accepted.
20. Comply with industry standard circuit polarity and loudspeaker wiring polarity. No cables shall be terminated with a polarity reversal between connectors at either end.
21. All system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No bare wire ends shall be accepted.
22. Heat-shrink type tubing shall be used to insulate and dress the ends of all wire and cables including a separate tube for the ground or drain wire.
23. All solder connections shall be made with rosin-core solder. Temperature controlled soldering irons rated at least 60 watts shall be used for all soldering work. No soldering guns, gas or butane, or temperature unregulated irons shall be used on the job site.
24. All mechanical connections shall be made with approved crimp lugs of the correct size and type for the connection. Wire nuts shall not be permitted except

inside speaker enclosures. Each connector shall be attached with the proper size controlled-duty-cycle ratcheting crimp tool which has been approved by the manufacturer of the connectors.

25. Conventional non-ratcheting type crimping tools are unacceptable, and shall not be used on the job site. The presence of such tools on the job site shall constitute evidence of mechanical connections made with unauthorized tools and shall provide sufficient grounds for rejection of all mechanical connections in the system, and the subsequent re-work of same.
26. Shields for audio cables shall be grounded at the input end only, of the various equipment items on the system to prevent potential for ground loops.
27. Where AV cable is installed in areas that are exposed to the view of end users, install AV cable and associated power cables inside nylon braided sleeving (wire loom). Examples of such areas include, but are not limited to cables installed to projectors and monitors, and cables installed to devices in/on lecterns such as touch panels and document cameras. Where security cables are specified for physical security to such devices, install the specified security cables inside the nylon braided sleeving along with the AV cables.

G. Identification and Labeling:
1. All cables, regardless of length, shall be identified with a machine-printed wrap-around labeling system at both ends. These labels shall be self laminating to ensure durability. The label format used shall be equal, or better than, the system detailed.
2. There shall be no unmarked cables any place in the system.
3. Marking codes used on cables shall correspond to codes provided with submittals, and/or the written documentation of the "as built" drawings.
4. All connectors, controls, equipment components, terminal blocks and equipment racks are to be permanently labeled in a format approved during the submittal process.
5. All equipment labels are to be permanently engraved in metal. Any alternative method shall be approved during the submittal process.
6. Clearly and permanently label all jacks, controls, connections, and so forth. Embossed or printed label tape shall not be used and is considered unacceptable for this system. Attach labels with double stick tape as required.
7. All labeling shall be completed prior to acceptance of the final system.

H. Repairs: Wherever walls, ceilings, floors, or other building finishes are cut for installation, or accidentally marred during installation, repair, restore, and refinish to original appearance.

3.3 GROUNDING

A. Provide equipment grounding connections for audio system as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to eliminate ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

C. Provide one #6 ground conductor with green insulation between all equipment racks and the main electrical panel ground bus. Connect at each end.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new, and retest until materials satisfactory performance and conditions are achieved.

C. Balance and Equalization: Perform the final balance and equalization. Comply with the equalization requirements stated above.

D. Designer/Engineer Final Review:
   1. Contractor shall assist Designer/Engineer in performing the final review, and spot checking the balance and equalization.
   2. Coordinate final inspection schedule with Designer/Engineer two weeks minimum prior to Consultant's final inspection.
   3. Have copy of red-lined as-built documents available at time of inspection.
   4. Have loose equipment (microphones, cables, etc) available at time of inspection.
   5. Assist Sound/Acoustic Consultant in final inspection of completed system.
   6. Provide the following test equipment in good working order:
      a. Battery operated hand-held 1/3 octave real-time audio spectrum analyzer with SPL meter and precision microphone.
      b. Digitally generated random pick noise generator, 20Hz-20kHz, minimum 2 hr repetition rate.
      c. Direct reading audio impedance meter, minimum 3 frequencies, 10% accuracy.
      d. Digital Volt-Ohmmeter.
      e. Audio oscillator, variable frequency, 20Hz-20kHz.
      f. Battery operated oscilloscope, 1 MHz minimum bandwidth.
      g. Necessary charger, cables, test leads, adapter, power strip, etc, for test equipment.
   7. Correct minor items so Designer/Engineer may certify satisfactory completion during his visit.
   8. Pay Designer/Engineer's additional fees and expenses if building or systems have not been completed properly or sufficiently, requiring Designer/Engineer to make subsequent visits to balance, equalize, inspect, or certify completion.

3.5 COMMISSIONING

A. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Comply with the requirements identified in section 27 41 00, project closeout.

B. Train Owner's non-technical users, and technical support personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of two hours training on two non-consecutive days (4 hours total). Provide training on days when training sessions are not provided to comply with the training requirements specified in other related sections. Include separate training sessions for non-technical users and for technical support personnel. Have ready, and refer to, all project documentation including, but not limited to, operating and maintenance instructions and As-built drawings. Allow the Owner to record any or all training sessions using audio and/or video recording equipment at their discretion.

C. Schedule training with Owner through the Architect, with at least 21 days advance notice.

3.6 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION 274113

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SECTION 274114 - VIDEO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The video systems will provide for monitor display of multiple video sources in multiple video resolutions and formats. Video signals will originate in media devices, be processed, selected and displayed.

B. This Section includes requirements for video system components including, but not limited to, the following:

1. Switchers
2. Matrix Switchers
3. Computer Interfaces
4. Various Media Source Devices
5. Scalers
6. Distribution Amplifiers
7. Monitors
8. Video Distribution Systems
9. Racks
10. Wire, Cable, and Connectors

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to this Section.

B. Related Sections: The following Division 27 sections contain requirements that relate to this section:

1. General Technology Systems Requirements
2. Basic Technology Systems Requirements
3. Basic Technology Systems Materials and Methods
4. Audio Systems
5. Control Systems

C. Related Sections: Several sections of Division 26 contain requirements that relate to this section.

1.3 SYSTEM DESCRIPTION

A. General: The video systems shall be complete and fully functioning systems for the selection, processing, distribution, and display of video signals on multiple types and sizes of monitors.

B. Video Functional Performance: Components and system features and functions shall include, but not be limited to:

1. Switching, processing, routing, distribution, and display of any video, data, or graphic signal up to and including native resolutions of 1920 x 1200.
2. Switching, processing, routing, distribution, and display of the specified video signal input formats include, but are not limited to composite video, component video, computer video, HDMI video, and DVI video.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified.

C. Shop drawings detailing video system including, but not limited to the following:

D.

1. Product data for each type of product specified.

2. Shop drawings detailing video system including, but not limited to the following:

   a. Connection panels.

   b. Rack elevations showing component arrangement inside equipment racks.

3. Wiring Diagrams detailing wiring for power, signal, and control. Provide actual hook-up drawings showing the connection point of each conductor. Single line drawings will not be accepted. Include all cable labeling on wiring diagrams. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

4. Maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 27 Section "Basic Technology Systems Requirements." Provide complete operations and maintenance manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover. Include the following:

   a. Equipment list showing quantity, make, model, and serial number.

   b. System operating instructions.

   c. System maintenance instructions.

5. Wiring codes for all system cable. (See "labeling", this section).

6. Proposed labeling for system components. (See "labeling", this section).

7. All special submittal instructions indicated on supplied design drawings.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of video system, components and accessories, of types, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience of A/V system projects similar to that required for this project. In addition, installers must have successfully completed a minimum of 3 similar installations over a period of 2 years prior to the date of the bid opening for this project. System installations must have included similar switchers, matrices, scalers, processors, and monitors. To qualify as similar, video systems must have included complete installation, set up, programming, calibration, and equalization of switchers, matrix routers, scalers, processors, and monitors. All such installation, set up, programming, calibration, and equalization work

must have been completed by a factory trained and certified technician of the specified switchers, matrix routers, scalers, and processors manufacturer. The certified technician must have successfully completed all relevant training courses recommended by the manufacturers of the above referenced equipment for proficiency in these skill sets. In addition, the certified technician must have been, and now be, a direct employee of the installer, in a permanent office staffed with factory qualified technicians, working for a minimum of 40 hours per week as a direct employee of the installer. The certified technician and factory trained installers must be the direct employees of the installer; sub-contracted, third party maintenance agreements, or similar arrangements are expressly prohibited, and do not qualify. Upon request, submit evidence of such qualifications to the Designer/Engineer. All of the above requirements must be complied with prior to the bid opening for this project.

C. Crestron Digital Media Training:Installer shall have on stall a Crestron DMC-E on stall and shall have a Crestron DMC-T certified technician on site during the installation of all Crestron DM devices.

D. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."

E. EIA Compliance: Comply with the following Technology Industries Association Standards.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

1.7 WARRANTY REQUIREMENTS

A. Video system shall be subject to warranty requirements as stated in section 27 41 16.00.

PART 2 - PRODUCTS

1.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by those manufacturers identified in the equipment list.

1.2 SYSTEM REQUIREMENTS

A. General: Provide a complete and fully functional video system using materials and equipment of types, sizes, ratings, and performances as indicated in the project drawings. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction in accordance with published product information. Coordinate the features of materials and equipment so they form an integrated system with components and interconnections matched for optimum performance of specified functions.

B. Video Projection System: Provide complete projection system set up services including but not limited to convergence, focusing, preset programming, and alignment. Include manufacturer direct services and on site support.

1. Set Up: Provide complete setup and convergence services as defined in the manufacturer's installation manual. Assure that all display devices automatically lock onto all owner designated horizontal scan frequencies and save to memory locations. Provide all equipment required to accomplish programming. At a minimum, without implying limitation, and in addition to those horizontal scan frequencies requested by the owner during the final system set up phase, program display systems to automatically lock onto horizontal scan frequencies for the following resolutions:

a. NTSC

b. VGA

c. WGA

d. SVGA

e. XGA

f. WXGA

g. WXGA+

h. SXGA

i. SXGA+

j. WSXGA+

k. UXGA

l. WUGA

m. QXGA

n. WQXGA

o. MAC II

p. MAC QUADRA

q. IBM workstations

r. UNIX workstations

s. SUN workstations

t. 720p

u. 1080i

v. 1080p

w. 1920 x 1200

2. All monitor images shall be free of visible vibration and/or motion. Provide vibration isolation and dampening equipment where required.

1.3 EQUIPMENT AND MATERIALS

A. General: Provide equipment selected from equipment list on drawings, or as substituted following the proscribed substitution process, using all solid-state components fully rated for continuous duty at the ratings indicated or specified. Select equipment for normal operation on input power supplied at 105-130 V, 60 Hz.

B. Furnish and install adaptor cables and patch cables which comply with all requirements specified in the project notes.

PART 3 - EXECUTION

1.1 EXAMINATION

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the video system work.

B. Do not proceed until unsatisfactory conditions have been corrected.

1.2 INSTALLATION

A. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three times the weight of the equipment being installed. Any structural mounting that is not able to meet this requirement due to the specific nature of the equipment, manufacturer's requirements or limitations of the facility shall not be installed without prior approval of the Architect. Install all boxes, equipment, hardware, and other materials plumb, level, and square.

C. Install all technology equipment and support equipment in all podiums, and the other millwork in a neat and cosmetically dressed-out manner. All saw cuts, holes and recesses into laminates and woodwork shall be straight, all radius and circular cuts shall be consistent, and all uneven surfaces shall be corrected. This shall include the use of moldings, grommets, bushings, laminates, and wood products as required to dress out the installation of equipment. Assure that the installation of equipment and panels in the technology racks and podiums are completed by using matching screws, hardware and grommets.

D. Electronics:

1. Assure sufficient ventilation for adequate cooling of equipment.

2. Install vent rack panels in unused spaces.

3. Securely fasten equipment plumb and square in place. Where equipment is installed in rack cabinets, utilize all fastening holes and cover open spaces with perforated panels.

4. Securely fasten relays and small components. Do not use sticky-back tape for fasteners.

5. Install balancing transformer on each unbalanced input or output that connects to device outside equipment cabinet, or that connects to balanced input or output within equipment cabinet.

6. Connect powered components to 120 VAC outlets on transient voltage surge suppressors. Do not connect to outlets on other components.

7. Leave sufficient service loops of uniform length on cables to allow operation of system with chassis outside cabinet.

8. All equipment shall be held firmly in place with proper types of mounting hardware as recommended and/or supplied by the manufacturer. All mounting hardware provided with equipment shall be used when practical. This shall include, but not be limited to, front and rear rack rails, angle brackets and rack mount kits. All equipment shall be installed so as to provide reasonable safety to the operator.

E. Cable, Wire, and Connectors:

1. All cable and wire shall be new and unspliced. Splicing of cables and conductors is expressly prohibited in any location other than the equipment racks. Splicing of audio and video cables will not be allowed in any location. Splicing of control conductors shall be accomplished via punch block or terminal strip connections only.

2. Additional cable length shall be provided at all connector locations. Duplex box, junction box, and floor box locations shall be installed with sufficient cable length behind cover plates to permit wiring maintenance and connector replacement in the future.

3. When cable runs utilize the vertical cable raceways located within walls, the acoustic integrity of the walls shall be maintained. All cables that pass through cover plates of junction boxes and raceways, through slab-to-slab walls, and through conduit lines shall be properly gasketted and sealed and all acoustic material shall be restored or replaced.

4. Separation between system cables and all other services shall be maximized to prevent and/or minimize the potential for electro-magnetic interference (EMI). Particular care shall be taken to ensure at least a 12" separation from electrical lines whenever feasible. At points where separation is unavoidable, distribution cables shall cross other services at right angles whenever practical to minimize EMI.

5. Cables shall be installed in a manner that shall ensure no signal cables are placed on top of any lighting fixtures, ceiling speakers, HVAC controls or sensing devices, fire safety and sprinkler system detection technology, or any other technology or mechanical equipment.

6. No cables shall be laid directly on top of T-bar grid ceiling tiles. Support cables installed outside of conduit at a maximum of four foot intervals from the building structure. Do not utilize support wires from other trades or systems.

7. System cables shall be installed in a manner that will not block access to other equipment or services, across removable service panels and/or in any other

manner to prohibit routine maintenance of HVAC systems, fire safety equipment and building mechanical control systems.

8. All exposed conductors inside of equipment racks shall be dressed with heavy duty neoprene heat-shrink tubing.

9. All inter-rack cabling shall be neatly laced, dressed, strain relieved and adequately supported.

10. After completion of wiring and cable installation, all trough and box covers shall be notched out and grommeted for clearance of the various cable bundles, (i.e., separate audio, video, and control). These panel covers shall be screwed back in place and all gaskets shall be restored or replaced.

11. Do not place any wires and cables for this system in any conduit, raceway, wireway or cable tray that is used for the mechanical systems of the building.

12. Provide connectors of the type and quality as detailed in this contract, and/or as required to meet the minimum bandwidth requirements of the equipment to which the connectors are terminated. The overall quantity of connectors shall not be limited by the quantities indicated in the drawings and shall be provided as required.

13. No connectors shall be installed in non-accessible locations or used for splicing cables. All connectors shall be new.

14. All connectors shall incorporate strain relief mechanisms which firmly grip the jacket of connected cables. All connectors shall be properly polarized to prevent improper seating. Connectors shall provide appropriate electrical characteristics for the circuitry to which they are attached.

15. All inner-rack cables shall be grouped according to the signals being carried to reduce signal contamination. Separate groups shall be formed for the following:

    a. Power

    b. Control

    c. Video

    d. Audio cables carrying signals less than -20 dBM.

    e. Audio cables carrying signals between -20 dBM and +20 dBM.

    f. Audio cables carrying signals over +20 dBM.

16. Route all cable and wiring within equipment racks, cabinets and millwork according to function, separating wires of different signal levels (microphone, line level, amplifier output, AC, control, etc.) by as much distance as possible. Neatly arrange, harness and bundle all cable with nylon U/V rated ties.

17. As a general practice, all power cables, control cables, and high level cables shall be run on the left side of equipment racks as viewed from the rear. All other cables shall be run on the right side of all equipment racks as viewed from the rear.

18. All cables, except video cables which must be cut to an electrical length, shall be cut to the length dictated by the cable run.

19. Terminal blocks, boards, strips or connectors, shall be furnished by the installer for all cables which interface with racks, cabinets, consoles, or equipment modules. Affix terminal blocks, boards, strips or connectors to equipment racks using screws only. Double sided tape will not be accepted.

20. Comply with industry standard circuit polarity and loudspeaker wiring polarity. No cables shall be terminated with a polarity reversal between connectors at either end.

21. All system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No bare wire ends shall be accepted.

22. Heat-shrink type tubing shall be used to insulate and dress the ends of all wire and cables including a separate tube for the ground or drain wire.

23. All solder connections shall be made with rosin-core solder. Temperature controlled soldering irons rated at least 60 watts shall be used for all soldering work. No soldering guns, gas or butane, or temperature unregulated irons shall be used on the job site.

24. All mechanical connections shall be made with approved crimp lugs of the correct size and type for the connection. Wire nuts shall not be permitted except inside speaker enclosures. Each connector shall be attached with the proper size controlled-duty-cycle ratcheting crimp tool which has been approved by the manufacturer of the connectors.

25. Conventional non-ratcheting type crimping tools are unacceptable, and shall not be used on the job site. The presence of such tools on the job site shall constitute evidence of mechanical connections made with unauthorized tools and shall provide sufficient grounds for rejection of all mechanical connections in the system, and the subsequent re-work of same.

26. Shields for audio cables shall be grounded at the input end only, of the various equipment items on the system to prevent potential for ground loops.

27. Where AV cable is installed in areas that are exposed to the view of end users, install AV cable and associated power cables inside nylon braided sleeving (wire loom). Examples of such areas include, but are not limited to cables installed to monitors, and cables installed to devices in/on lecterns such as touch panels and document cameras. Where security cables are specified for physical security to such devices, install the specified security cables inside the nylon braided sleeving along with the AV cables.

F. Identification and Labeling:

1. All cables, regardless of length, shall be marked with wrap-around, or better, number or letter cable markers at both ends. These labels shall be self laminating to ensure durability. The label format used shall be equal, or better than, the system detailed.

2. There shall be no unmarked cables any place in the system.

3. Marking codes used on cables shall correspond to codes provided with submittals, and/or the written documentation of the "as built" drawings.

4. All connectors, controls, equipment components, terminal blocks and equipment racks are to be permanently labeled in a format approved during the submittal process.

5. All equipment labels are to be permanently engraved in metal or plastic laminate and affixed with double-stick tape. Any alternative method shall be approved during the submittal process.

6. Clearly and permanently label all jacks, controls, connections, and so forth, with engraved laminated plastic labels. Embossed or printed label tape shall not be used and is considered unacceptable for this system. Attach labels with double stick tape as required.

7. All labeling shall be completed prior to acceptance of the final system.

G. Extended Display Identification Data (EDID):

1. All devices shall provide complete compatibility with analog and digital EDID data, facilitating display image specifications to source devices. Set EDID values in all equipment items in compliance with the native resolution of the specified display devices and the manufacturer's recommended practices.

H. High-bandwidth Digital Content Protection (HDCP):

1. All digital video devices shall provide complete compatibility with HDCP content protection ensuring all HDCP content can be displayed on all monitors.

I. Repairs: Wherever walls, ceilings, floors, or other building finishes are cut for installation , repair, restore, and refinish to original appearance.

1.3 GROUNDING

A. Provide equipment grounding connections for satellite earth-station systems and components, including dish antenna and supporting structures, and lead-in wires to antenna-discharge units. Tighten connections in accordance with manufacturer's recommended tightening torques. If not manufacturer-specified, comply with tightening torques specified in UL Stds 486A and B to assure permanent and effective grounds.

B. Provide equipment grounding connections for audio system as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

C. Ground equipment, conductor, and cable shields to eliminate shock hazard and to eliminate ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

D. Provide one #6 ground conductor with green insulation between all equipment racks and the main electrical panel ground bus. Connect at each end.

1.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new, and retest until materials satisfactory performance and conditions are achieved.

C. Designer/Engineer Final Testing, Image Observation, and Review:

1. Contractor shall assist Designer/Engineer in performing the final testing, image observation, and review.

2. Coordinate final inspection schedule with Designer/Engineer two weeks minimum prior to Consultant's final inspection.

3. Have copy of red-lined as-built documents available at time of inspection.

4. Have loose equipment (monitors, patch cables, etc) available at time of inspection.

5. Assist Designer/Engineer in final review, testing, and image observation of completed system(s).

6. Provide the following test equipment in good working order:

   a. Digitally generated test signal generator for all signals identified above. At a minimum, without implying limitation, signal generator shall output cross hatch, alternating pixel, grey scale, and color bar patterns.

   b. Digital Volt-Ohmmeter.

   c. Field strength meter.

   d. Battery operated oscilloscope, 1 MHz minimum bandwidth.

   e. Necessary charger, cables, test leads, adapter, power strip, etc, for test equipment.

7. Correct minor items so Designer/Engineer may certify satisfactory completion during his visit.

8. Pay Designer/Engineer's additional fees and expenses if building or system have not been completed properly or sufficiently, requiring Designer/Engineer to make subsequent visits to balance, equalize, inspect, or certify completion.

1.5 COMMISSIONING

A. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Comply with the requirements identified in section 27 41 16.00, project closeout.

B. Train Owner's non-technical users, and technical support personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of 4 hours training on two non-consecutive days (8 hours total). Include separate training sessions for non-technical users and for technical support personnel. Have ready, and refer to, all project documentation including, but not limited to, operating and maintenance instructions and As-built drawings. Allow the Owner to record any or all training sessions using audio and/or video recording equipment at their discretion.

C. Schedule training with Owner through the Architect, with at least 21 days advance notice.

1.6 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION 274114

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SECTION 274115 - CONTROL SYSTEMS

A. SYSTEM DESCRIPTION
   1. The control panels shall communicate with all specified A/V system components via the specified control system devices. All programming source code required to make the touch panel/button panel buttons operational shall be developed and written by the installer as required to produce a fully functioning system.
   2. The Installer shall provide the complete source code to the Owner for the completed functioning control system. The source code shall be un-locked, and in a format that can be fully accessed by the Owner. In addition, the Installer must relinquish ownership of said software code, in writing, to the Owner.

B. SUBMITTALS
   1. See section 274113 – Audio systems
   2. Installer's Qualifications: Firms with at least 5 years of successful installation experience of A/V system projects similar to that required for this project; and who are authorized dealers of Crestron. In addition, the certified programmer must have been, and now be, a direct employee of the installer, in a permanent office staffed with factory qualified technicians, working for a minimum of 40 hours per week as a direct employee of the installer. The certified programmer and factory trained installers must be the direct employees of the installer; sub-contracted, third-party maintenance agreements, or similar arrangements are expressly prohibited, and do not qualify.

C. MANUFACTURERS
   1. Manufacturers: Crestron video equipment and other manufacturers as specified on the drawings.

D. SYSTEM REQUIREMENTS
   1. General: Provide a complete and fully functional control system using materials and equipment of types, sizes, ratings, and performances as identified in the equipment list.
   2. During the final software programming, the installer shall work in a close and cooperative manner with the Designer/Engineer and Owner's representative to make additional modifications, and/or changes in programming procedural events, changes in touch panel functions, and changes in programming features as needed at no additional cost to the owner. These adjustments to the system programming outline in this section shall include, but not be limited to, changes in the system programming code, page layouts, equipment operating modes, and system logic from the parameters outlined here to ensure the flexible and user-friendly operation of the A/V system. Include all costs necessary to make moderate changes to the control system programming code and touch panel buttons and pages in the base bid.

E. INSTALLATION
   1. 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:
   2. 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.

3. Any modifications with respect to the mandated IP Address Assignment Procedure must be approved during the submittal process.
4. Technology: See 274113 – Audio Systems.
5. Cable, Wire, and Connectors: See 274113 – Audio Systems.
6. Identification and Labeling: See 274113 – Audio Systems.

F. FIELD QUALITY CONTROL
1. See 274113 – Audio Systems.

SECTION 28 13 00 - ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes an access control system consisting of on-premise hosted Access Control Software, Access Control Server/Appliance, Access Control panels, Card Reader devices, Cabling, Power Supplies and Equipment Enclosures, System Configuration, Commissioning, and Programming.

B. Project scope:
   1. Installation of new cabling to new doors. Installation of card readers, door contacts, request to exist devices and interface with electric locks.
   2. The access control system is to be partitioned in to the different group. Access to the different groups is to be set up so that the group can set up card holders in their respected area and the main entrances in to the building.

C. Definitions:
   1. Open Supervised Device Protocol (OSDP): An access control communications standard.
   2. Secure Copy Protocol (SCP): A means of securely transferring computer files between a local host and a remote host or between two remote hosts.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate with Owner or Owner's representative regarding network configuration and estimated bandwidth utilization prior to performing network connections.

B. Sequencing / Scheduling: Provide to Owner or Owner's representative a schedule and list of participants required to attend coordination and progress update meetings.
   1. Owner representative(s) for Facilities Management, Information Technology (IT) Services, and Security Management.
   2. Project Manager.
   3. Manufacturer's Representative.

1.3 INFORMATIONAL SUBMITTALS

A. Product Data: Manufacturer's product information and data sheets for each product specified in this section, including:
   1. System overview drawings.
   2. Typical installation means and methods.
   3. Recommendations and requirements for proper storage and handling.

B. Shop Drawings:
   1. Submit Manufacturer's approved shop drawings detailing the section and elevation views of each product to be installed.
   2. Coordinate with locations listed on Contract Drawings.

C. Certifications
   1. Submit Manufacturers certifications for systems being installed.

D. Warranty Information:
   1. Submit confirmation and details of manufacturer's warranty, extended warranty, and replacement policies.

E. System Support Resources:
   1. Submit a list of available manufacturers providing fee based professional services available to the Contractor or Owner, including but not limited to the following:
      a. Training.
      b. Installation.
      c. Commissioning.
      d. Remote diagnostics and integration with 3rd party software and hardware systems.

1.4 CLOSEOUT SUBMITTALS

A. Supply licensing and registration information for all software, hardware, firmware, operational, and administrative licenses.

B. Supply network configuration backup files, restoration application and instructions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide products from manufacturer(s) with a minimum of 5 years in manufacturing access control specified in this section.

B. Supplier Certifications: Provide products from a supplier in compliance with the following:
   1. Department of Homeland Security Safety Act Certified.
   2. NISPOM Compliance (National Industrial Security Program Operating Manual).
   3. HSPD-12 and FIPS201-2 Certified.
   4. GSA Approved product list.

C. Installer Qualifications:
   1. Installer must be licensed to install access control and security equipment as required by authority having jurisdiction.
   2. Installer must have certified staff on access control products prior to bid date.
   3. Installer must be in good standing by the manufacturer prior to bid date.
   4. Installer must be capable of providing references that will attest to successful completion of projects of similar scope as the work noted in this section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Manufacturer: OSSI

A. Manufacturer List:
   1. OSSI- Intelli-site (Bases of design)

2.2 ACCESS CONTROL SOFTWARE

A. Basis of Design: OSSI- Intelli-site

B. Access Control Software Capacities:

1. Intelligent Controllers: 1024 per appliance, allowing geographic independence from appliance via IP communication.
2. Access Control System Appliances Supported: Up to 100 linked appliances using replication.
3. Events Stored: Up to 150,000,000 per appliance.
4. Events Stored: Up to 75,000,000. Per professional appliance.
5. Sub-Panels: Up to 32 per intelligent controller.
6. Doors: Up to 64 per intelligent controller.
7. PIN Length: Between 4 and 8 digits.
8. Card Formats: Up to 128 per appliance.
9. Time Schedules: 255 per intelligent controller.
10. Holidays: 255 per intelligent controller.
11. Identity and Operator Database: Up to 500,000.
12. Client Connections: Up to 50.

2.3 ACCESS CONTROL SOFTWARE COLLABORATIONS

A. Database Collaborations and Integrations: Provide access control software capable of integration with the following industry standard third-party databases.
   1. Bidirectional:
      a. REST API Integration.
   2. Pull Only:
      a. Lightweight Directory Access Protocol (LDAP/Active Directory).
      b. Structured Query Language (SQL) Server.
      c. Oracle Relational Database Management System (RDBMS).
      d. Comma Separated Value (CSV).
   3. Push Only:
      a. Extensible Markup Language (XML) for Event Push.

2.4 ACCESS CONTROL HARDWARE INTEGRATIONS

A. Panel Hardware:
   1. Compass.

B. Supported Reader Hardware:
   1. Readers capable of OSDP and Wiegand data format.
   2. HID: Signo.

C. Request to Exit:
   1. Bosch DS160 or hardware built in.

D. Door Contacts
   1. GRI or Equivalent
      a. Door contacts are to be recessed or have armored cabling for surface mount.

E. Electric Locks:
   1. By Division 8.

F. Credential Technologies:
   1. Credentials capable of Open Card format (PROX, MiFare, DESFire CSN).
   2. HID Global: All Physical (SEOS, iClass, Prox, Mifare, DESFire) and Mobile (Origo).
   3. Match existing card formats currently in use.

G. Power Supplies: Provide one of the following power supplies that are manufacturer-prepared to support access control panels:

1. Altronix or equivalent

2.5 ACCESS CONTROL SOFTWARE INTERFACE

A. Web-Based Access Support: Provide access control software with browser-based access to system applications including support for industry standard desktop and mobile web browsers.

B. Dynamic User Interface: System supports the following functionality in a vertical collapsable menu:
   1. Monitor events, alarms, and hardware status in real time.
   2. View and manage identifies in real time.
   3. Reporting
   4. Dashboard and Areas
   5. Collaborations
   6. Settings

C. Events and Alarms: Provide system that allows administrators the ability to create, configure, and prioritize events and alarms and communicate information about the generation of the event or alarm to the operator with guidance for responding to the event or alarm. Events will support two levels: system level events affect all objects in the system; field level events affect only the object they are configured on.

D. Access Groups: Provide system that allows administrators the ability to create groups of card readers and schedules such that card readers can allow or restrict access to areas based on schedules.

E. Identity Records: Provide a system with integrated identity management, allowing imports of data from supported databases. Each identity supports access control based on groups and roles as well as individual overrides. Include functionality to customize identity and token forms in base software. Provide identity records capable of management and synchronization between multiple sites.

F. Roles: Support a role-based permission method allowing one or more roles to be assigned to identities to determine physical and logical access.

G. Macros: Provide system capable of linking one or more events to macros such that a single event may execute up to 30 macros. System must support minimum of 255 macros per intelligent field controller.

H. Device Template Configuration: Provide access control system that supports templates to automatically populate standard parameter fields in groups for new or existing doors, wires, readers, and input/output devices.

I. Encryption: Provide access control system that supports the following encryption methods:
   1. TLS 1.2: Require TLS encryption between the access control system, Mercury controllers, and external systems.
   2. Custom Certificates: Require self-signed or certificate authority certificate to harden access control system. Certificates will authenticate Mercury panels to the access control system.
   3. FIPS 140-2: Require access control server to utilize FIPS 140-2 compliant ciphers only.
   4. FIPS 201-2: Require large-encoded card formats for FIPS 201-2 certified pivClass solution.

J. Custom Device Mappings: Administrators may assign a unique group of alarm attributes to specific device-alarm combinations to override global settings of generic attributes.

K. Dashboard: Allow creation of a dashboard for real-time status and actions of hardware components on a single screen that can also filter by name, status, appliance, or group.
   1. Hardware Status:
      a. Panels: Communication, power, tamper, and battery.
      b. Sub-Panels: Communication, power, and tamper.
      c. Inputs: Inactive, active, trouble, and masked.
      d. Outputs: Off, on, and trouble.
      e. Doors: Communication, tamper, battery, unlocked, help, masked, and forced.
      f. Appliances: RAM, program, database, CPU load, and port status.
   2. Monitor:
      a. Panels: Device status, security status, name, model, firmware, IP address, MAC address, access port, callback port, cards in use, and last communication.
      b. Sub-Panels: Device status, name, panel, type, port, address, and firmware.
      c. Inputs: Device status, input name, subpanel, EOL resistance, and address.
      d. Outputs: Device status, output name, subpanel, schedule, and address.
      e. Power Supplies: Power supply name, installed status, status, and logs.
      f. Access Control Doors: Status, name, panel, door state, door mode, and override status.
   3. Manipulate Access Control Doors:
      a. Door actions: Grant, restore, unlock, locks no access, disable.
      b. Door mode: Card only, card and PIN, card or PIN, PIN only, facility code only, exit leaves open, toggle + exit leaves open.
      c. Door Forced: Mask forced, unmasked forced.
      d. Door Held: Masked held, unmasked held.
      e. Installed: Install, uninstall.
   4. Areas
      a. Status of defined areas
      b. Management of Identities in areas.

L. Scene and Mapping Interface: Provide an interface for creating customizable layouts, including floorplans, reader locations, and buttons that can trigger actions.
   1. Dynamic Icons: Icons on map must change collor and provide real time information of:
      a. Immediate Attention Required
      b. Attention Required
      c. Unusual
      d. Normal
   2. Actions: Card readers indicate alarm via icon and allow for card only, card and pin, card or pin, pin only, facility code only, disable, unlock, lock, grant, restore, mask held, unmask held, and trace actions.
   3. Occupancy/Mustering: Maps will provide real-time occupancy of a defined area.
   4. Programmable Buttons: Scenes/Maps will provide mapping of buttons and text to perform actions such as lockdown or setting schedules.

M. Verification Interface: Provide web-browser-enabled connection to access control software allowing a user to review information about card holders entering or existing up to four (4) doors in real time. Information to include badge photo, transaction time, and date via any device with a compatible browser.

N. Virtual Verification Station: Provide web-browser-enabled connection to the access control software to allow a user to visually confirm the identity and authorization of a person attempting entry to a controller area via a mobile device such as a tablet or smartphone.

O. Access Control Software Reporting: Generate, filter, edit, and customize system reports including the automated generation and distribution of customized reports in PDF and CSV formats.

2.6 ACCESS CONTROL SOFTWARE ADMINISTRATION

A. Backup: Provide access control software capable of backing up via USB drive, local appliance, windows network share, or secure copy protocol.

B. Database Replication: Replicate database from 1 to 100 appliances for distributed identity control.

C. Password Update: Provide ability for administrator to require operator update password at next login.

D. Updates: Provide access control software capable of automatically updating the following:
1. Operating System: Version, service packs, and security vulnerabilities.
2. Field Devices: Firmware versions.

E. Upgrade Functionality: Provide access control software capable of automatically upgrading software licensing.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to installation, ensure Access Control Hardware Appliance is capable of required Access Control Software Features and Integrations.

3.2 INSTALLATION

A. Install system according to manufacturer's written instructions.
1. Develop, install, and test software and databases for complete and proper operation of systems involved. Activate and install all software and accessory software licenses.
2. Setup and program entire system so that no additional programming is required after Substantial Completion, including setup of available software features.
3. Perform a full system back-up at completion of initial programming and deliver configuration and transaction backups to Owner.
4. Perform field software changes after the initial programming session to "fine tune" operating parameters and sequence of operations based on revisions to the Owner's operating requirements including the creation of time schedules, holidays, new card formats, etc. Create user hierarchy with access permissions. Set up notifications.
5. Add current card users and cards so hardware cut-over is seamless and does not cause interruption to personal activities.
6. Test equipment and configure system in accordance with instructions provided by manufacturer prior to installation.

B. Ensure products are equipped with latest and most up-to-date firmware and/or software by manufacturer.

C. Review configurable features of device with Owner's Representative and establish a punch list for standard, device specific, location specific and access control software-specific configuration of device(s).

D. Program and configure devices in accordance with this punch list so no additional programming is required for operation by user.

E. Configure equipment requiring users to log on using a password with user/site-specific password/passwords.

F. No system/product default passwords allowed.

3.3 CLOSEOUT ACTIVITIES

A. Demonstration:
   1. Demonstrate administration and operation of access control system.
   2. Demonstrate how an authorized user can log in and make changes to configuration of card holders, door access, and run reports.
   3. Demonstrate how to operate functionality configured for this project as defined by configuration punch list.

B. Fine Tuning:
   1. Perform field software changes after initial programming session to "fine tune" operating parameters and sequence of operations based on any revisions to Owner's operating requirements.

C. License Assignment:
   1. Register software, hardware, firmware, operational or administrative licenses necessary for to operate or administer devices to Owner including the end user license agreement (EULA).
   2. Deliver to Owner's Representative proof of license registration from product manufacturer.

D. Device Configuration Backup:
   1. Using access control system backup functionality, perform a full system backup at the completion of the initial programming to a USB drive or customer local network shared folder (preferred option). Schedule backup function to execute system backup periodically.
   2. Deliver configuration backup files, restoration application and instructions detailing for restoration of back-up configuration.

END OF SECTION 281300

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SECTION 282300 - VIDEO SURVEILLANCE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide and install a complete Video Surveillance System, which is identified as the Closed-Circuit Television System hereinafter referred to as the CCTV System as specified in this section.

B. The system will be connected to an on-premise video recording system. Video recording storage will be based upon minimum
   1. Resolution: 2 MP (Min)
   2. Frames per second: 15 FPS (for Storage Calc Only)
   3. Quality: High
   4. Motion: 30%
   5. Days of recording: 90 days for DMV Cameras, 30 for all other.

1.2 RELATED WORK

C. For firestopping application and use, Section 07 8400, FIRESTOPPING.

D. For labeling and signs, Section 10 1400, SIGNAGE.

E. For connection of high voltage, Section 26 0511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.3 QUALITY ASSURANCE

F. The Contractor shall be responsible for providing, installing, and the operation of the CCTV System as shown. The Contractor shall also provide certification of training from manufacturer of control software and hardware as required.

G. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.

H. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

I. The Contractor or security sub-contractor shall provide references to Consultant of similar projects completed of size and scope.

1.4 SUBMITTALS

J. Submit the following items; Shop Drawings, Product Data, and Samples.

K. Provide certificates of compliance with Section 1.3, Quality Assurance.

L. Provide Product Data cut sheets for each item to be installed.

M. Provide a pre-installation and as-built design package in electronic format, drawing submittals shall be per the established project schedule.

N. Pre-installation design and as-built packages shall include, but not be limited to:
   1. Index Sheet that shall:

   a. Define each page of the design package to include facility name, building name, floor, and sheet number.
   b. Provide a list of all security abbreviations and symbols.
   c. Reference all general notes that are utilized within the design package.
   d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
      1) Outline all general and job specific work required within the design package.
      2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
   a. Include a title block as defined above.
   b. Define the drawings scale in both standard and metric measurements.
   c. Provide device identification and location.
   d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
   e. Identify all pull box and conduit locations, sizes, and fill capacities.
   f. Address all general and drawing specific notes for a particular drawing sheet.
3. A riser drawing for each applicable security subsystem shall:
   a. Indicate the sequence of operation.
   b. Relationship of integrated components on one diagram.
   c. Include the number, size, identification, and maximum lengths of interconnecting wires.
   d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
4. A system drawing for each applicable security system shall:
   a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
   b. Provide full detail of all system components wiring from point-to-point.
   c. Identify wire types utilized for connection, interconnection with associate security subsystems.
   d. Show device locations that correspond to the floor plans.
   e. All general and drawing specific notes shall be included with the system drawings.
5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
   a. Device ID.
   b. Device Location (e.g. site, building, floor, room number, location, and description).
   c. Mounting type (e.g. flush, wall, surface, etc.).
   d. Power supply or circuit breaker and power panel number.
   e. In addition, for the CCTV Systems, provide the camera ID, camera type (e.g. fixed or pan/tilt/zoom (P/T/Z), lens type (e.g. for fixed cameras only) and housing model number.

6. Detail and elevation drawings for all devices that define how they were installed and mounted.

O. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

P. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per the General Requirements, Section 01 0000, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

Q. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
1. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
2. American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA):
3. Institute of Electrical and Electronics Engineers (IEEE):
4. IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
5. Power over Ethernet Standard (POE+)
6. National Electrical Contractors Association (NECA):
7. Installing Closed Circuit Television (CCTV) Systems
8. National Fire Protection Association (NFPA):
9. Article 780-National Electrical Code
10. Federal Information Processing Standard (FIPS):
11. Security Requirements for Cryptographic Modules
12. Underwriters Laboratories, Inc. (UL):
13. Standard for Surveillance Camera Units
14. Standard for Surveillance Closed Circuit Television Equipment
15. Open Network Video Interface Forum (ONVIF):
16. Core Specification for device compliance IP Enabled CCTV

1.6 WARRANTY OF CONSTRUCTION

R. Warrant CCTV System work for two (2) years starting after the signed substantial completion. Provide pricing for additional years of warranty up year 5.

PART 2 – PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All equipment associated within the CCTV System shall be UL 3004 compliant and rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.

B. All equipment shall operate on a 120 volts alternating current (VAC); 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification.

C. The system shall be designed, installed, and programmed in a manner that will allow for ease of operation, programming, servicing, maintenance, testing, and upgrading of the system.

D. All equipment and materials for the system will be compatible to ensure correct operation.

2.2 MANUFACTURERS

E. BASE BID MANUFACTURERS:
   1. Avigilon

F. Subject to owner's final approval of bid responses submitted by contractor, the following manufacturer's products will be considered in bid responses; and as compliant to these technical specifications. In order to assure achievement of maximum system performance, individual components must be performance-certified to match interfacing and interactive components. Products must not be mixed and matched between different vendors. Vendor solutions must be implemented as single vendor end-to-end engineered systems to assure compatibility.

G. Substitution of system components with other Manufacturers shall follow substitution procedures in Section 01 3300.

H. Equipment Racks and Cabinets
   1. Project will use the div 27 cabinets.

I. Cable / Wire
   1. Cabling by Security contractor.

J. Software Management System
   1. Avigilaon
   2. 1 Dev lic for each camera.

K. Network Switching Gear
   1. Ciscco
   2. Hp

L. Recording Media
   1. Added to existing campus server.

M. Cameras
   1. Avigilon

2.3 EQUIPMENT ITEMS

N. CCTV system shall meet following requirements:
   1. All Cameras will be EIA 330 and UL 983 compliant as well as:
      a. Shall be ONVIF 2.6.1 and IEEE 802.3at compliant.
      b. Shall be utilized for interior and exterior purposes.
      c. A Category CAT6 cable (violet)will be the primary source for carrying signals up to 300 ft. (100 m) from a switch or network server. If any camera is installed greater than 300 ft. (100 m) from the controlling device, then one of the following will be required:
         1) A remote UL Compliant Midspan IEEE 802.3at compliant repeater device, installed in a secure weatherproof and accessible location at or before 300 ft from the head-end, and within 300ft of the camera, capable to extend the signal an additional 300ft.

2) A signal converter will be required to convert from a CAT6 cable over to a fiber optic or standard signal cable. The signal will need to be converted back to a CAT6 cable at the controlling device using a signal converter card.

d. Shall:
   1) Be routed to a controlling device via a network switcher or direct connection to a network server.
   2) Provide at a minimum 2 Megapixel with built-in complementary color filter for accurate color with no image lag or distortion.
   3) Be a programmable IP address that allows for installation of multiple units in the same Local Area Network (LAN) environment.
   4) Incorporate a minimum of Transmission Control Protocol (TCP/IP), User Datagram Protocol (UDP), Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP), Address Resolution Protocol (ARP), Real-Time Transport Protocol (RTP), Real-Time Streaming Protocol (RTSP), Dynamic Host Configuration Protocol (DHCP), Network Time Protocol (NTP), Simple Mail Transfer Protocol (SMTP)

e. Technical Characteristics:

Video Standards	H.264; M-JPEG
Video Data Rate	User Selectable / Constant or Variable 15FPS minimum at H.264
Image Resolution	2.0 MP Minimum
Streaming Video Resolution	Main Stream user selectable up to full Capability Sub-Stream user selectable
Streaming Frame Rate	1-25/30 IPS (PAL/NTSC);Field/frame based coding
Network Protocols	RTSP, RTP, UDP, TCP/IP, HTTP, FTP
Firmware Upgrades	Remote Push
Configuration	Via web browser, built-in web server interfaces
Video Out	HTTP / RJ-45
Sensitivity	0.5 lux (color) 0.25 lux B/W
Minimum Illumination	0.30 lux (color)0.12 lux B/W
Video Signal-to-Noise Ratio	50 dB
Video Signal Gain	21 dB, (max) Electronic Shutter Automatic, up to 1/150000 sec. (NTSC)
Alarm In	Automatic sensing (2500 - 9000 K)
Input Voltage	VDC: 11-14 VDC (500 mA) PoE: IEEE 802.3at compilant

2. Lenses: Shall be utilized in a manner that provides maximum coverage of the area being monitored by the camera. The lenses shall:
   a. Be MegaPixel rated accordingly for IP Cameras.
   b. Be all glass with coated optics.
   c. Have mounts that are compatible with the camera selected.
   d. Have a maximum f-stop of f/1.3 for fixed lenses, and a maximum f-stop of f/1.6 for variable focus lenses.
   e. Be equipped with an auto-iris mechanism.
   f. Have sufficient circle of illumination to cover the image sensor evenly.
   g. Not be used on a camera with an image format larger than the lens is designed to cover.
3. Three types of lenses shall be utilized for both interior and exterior fixed cameras:
4. Manual Variable Focus w/ Auto iris
5. Fixed lens w/ Auto Iris
6. Manual Variable Focus:
   a. Shall be utilized in large areas that are being monitored by the camera. Examples of this are perimeter fence lines, vehicle entry points, parking areas, etc.
   b. Shall allow for setting virtually any angle of field, which maximizes surveillance effects.
   c. Technical Characteristics:

Image format	CMOS or 1/3 inch MegaPixel IP
Focal length	2.8mm X 12mm
Iris range	F1.4 to close
Focus range	1m (3.3 ft)
Back focus distance	10.05 mm (0.4 in)
Angle view Wide (1/3 in)	53.4 x 40.1
Angle view Tele (1/3 in)	5.3 x 4.1
Iris control	Auto
Focus ctrl	manual
Zoom ctrl	manual

7. Auto Iris Fixed
   a. Shall be utilized in areas where a small specific point of reference is to be monitored. Examples of this are doorways, elevators, cashier booths, etc.
   b. To determine the exact size of the fixed lens required, complete a focal length calculation using either a focal length calculator or a focal length chart provided by the product manufacturer.
   c. Technical Characteristics:

Image format	1/3 inch / Megapixel	1/3 inch / Megapixel	1/3 inch / Megapixel
Focal length	2.8 mm	4 mm	8 mm
Iris range	F1.2 – 200	F1.2 – 200	F1.2 - 200
Min. Object	0.3 m (1 ft)	0.3 m (1 ft)	0.3 m (1 ft)
Lens mount	CS-mount	CS-mount	CS-mount
Angle of view	94 X 72	64 X 49	33 x 25

Focus control	Manual	Manual	manual

8. Video Display Equipment (not required)
   a. Will consist of 24" color monitors and shall be HDTV compliant.
   b. Shall be able to display analog, digital, and other images in either Composite, HDMI, and DVI format associated with the operation of the Video Management System (VMS).
   c. Shall have on-board controls that provide for power on/off, horizontal and vertical hold, brightness, contrast, and accept multiple inputs either directly or indirectly.
   d. Liquid Crystal Display (LCD) or Light Emitting Diode (LED) Flat Panel Display Monitor
   e. Technical Characteristics:

Sync Format	NTSC
LED Refresh	240Hz Minimum
Resolution	1080P Minimum up to 4k
Dynamic Contrast Ratio (CR)	500,000:1 Minimum
Viewing Angle	140° horizontals, 130° verticals
Video 1	DVI-D; HDMI
Video 2	HDMI ; 4K

O. Camera Housings and Mounts:
   1. This section pertains to all interior and exterior housings, domes, and applicable wall, ceiling, corner, pole, and rooftop mounts associated with the housing. Housings and mounts shall be specified in accordance to the type of cameras used.
   2. All cameras and lenses shall be enclosed in a tamper resistant housing. Any additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing. All mounting bolts, nuts, or screws shall be tamperproof.
   3. The camera and lens contained inside the housing shall be installed on a camera mount. All additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
   4. Environmentally Sealed
      a. Shall:
         1) Be designed in manner that it provides a condensation free environment for correct camera operation.
         2) Operate in a 100 percent condensing humidity atmosphere.
         3) It shall contain camera mounts or supports as needed to allow for correct positioning of the camera and lens.
         4) The housing and sunshield are to be painted to match attached structure.
      b. All electrical and signal cables required for correct operations shall be supplied in a hardened carrier system from the controller to the camera.
      c. The mounting bracket shall be adjustable to allow for the housing weight of the camera and the housing unit it is placed in.
      d. Accessibility to the camera and mounts shall be taken into consideration for maintenance and service purposes.

5. Indoor Mounts
    a. Ceiling Mounts:
        1) This enclosure and mount shall be installed in a finished or suspended ceiling.
        2) The enclosure and mount shall be fastened to the finished ceiling, and shall not depend on the ceiling tile grid for complete support.
        3) Suspended ceiling mounts shall be low profile, and shall be suitable for installation with support.
    b. Wall Mounts:
        1) The enclosure shall be installed in manner that it matches the existing décor and placed at a height that it will be unobtrusive, unable to cause personal harm, and prevents tampering and vandalism.
        2) The mount shall contain a manual 3-axis head that will provide 360 degrees of horizontal and vertical positioning from a horizontal position, and has a locking bar or screw to maintain its fixed position once it has been adjusted.
6. Interior Panoramic Domes (180 to 360 degree)
    a. The interior dome shall be a pendant mount, pole mount, ceiling mount, surface mount, or corner mounted equipment.
    b. The lower portion of the dome that provides camera viewing shall be made of acrylic or glass and shall have a light attenuation factor of none.
    c. The housing shall be equipped complete with wiring, wiring harness, connectors, or any other hardware and equipment as needed to provide a fully functional unit.
7. Exterior Panoramic Domes (180 to 360 degree)
    a. The exterior dome shall meet all requirements outlined in the interior dome paragraph above.
    b. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity.
8. Exterior Wall Mounts
    a. Shall have an adjustable 3-Axis head for mounting the camera.
    b. Shall be constructed of aluminum, stainless steel, or steel with a corrosion-resistant finish.
    c. The head shall be adjustable for not less than plus and minus 90 degrees of pan, and not less than plus and minus 45 degrees of tilt. If the bracket is to be used in conjunction with a pan/tilt, the bracket shall be supplied without the adjustable mounting head, and shall have a bolt-hole pattern to match the pan/tilt base.
    d. Shall be installed at a height that allows for maximum coverage of the area being monitored.

P. Controlling Equipment (Exisiting)
1. Shall be utilized to call up, operate, and program all cameras associated CCTV System components.
2. Will have the ability to operate the cameras locally and remotely. A network server shall be utilized as the CCTV System controller. (See VMS Sec. 2.2C)
3. The controller shall be able to fit into a standard 19" (47.5 cm) equipment rack.
4. Control and programming of VMS via mouse keyboard, or via specialized CCTV keyboards shall be available at each workstation. All keyboards shall:

a. Be located at each monitoring station.
b. Be addressable for programming and forensic purposes.
c. Provide interface between the operator and the CCTV System.
d. Provide full control and programming.

5. VMS Software will have minimum operator capabilities:
   a. Take multiple camera inputs and route them to multiple monitoring stations.
   b. Allow for centralized user management controlling configurations.
   c. Provide live viewing of all cameras.
   d. Provide P/T/Z, focus, and iris control of all unitized cameras.
   e. Be expandable to allow for the addition of multiple cameras and monitoring stations over the life of the system visual identification system by utilizing network connection.
   f. Have the ability to be programmed either locally or remotely.
   g. Remotely operate multiple cameras from multiple stations.
   h. Be able to interface with legacy systems as well as NVR systems for recording, playback, and backup of all events.
   i. Utilize TCP/IP connections for integration with the VMS computer station.
   j. Shall have a programmable alarm interface that is compatible with all associated security subsystems either via hardware or software.
   k. The response time to an alarm input shall not be less than 200 milliseconds from the time an alarm is sensed until a picture is displayed on a monitor.
   l. The software shall have a built in buffer to allow for back-log of alarms. These alarms shall be viewable by an operator.
   m. Be configured, i.e. camera names, monitor names, sequences, alarms and alarm actions, etc. utilizing the configuration program and tools provided by the software manufacturer.
6. Network Video Recorder
   a. Allow for the transmission of live video, data, and audio over a 100/1000 Base-T Ethernet network.
   b. Shall record video to a hard drive-based digital storage medium in H.264 or H.265 format.
   c. Shall meet the following minimum requirements:
      1) Record capable of minimum rate of 30 IPS per video stream.
      2) Shall provide instantaneous playback of all recorded images.
      3) Be IP addressable.
      4) Have built-in digital motion detection with masking and sensitivity adjustments.
      5) Easy playback and forward/reverse search capabilities with minimum 90-day storage capability for all cameras.
      6) Complete audit trail database, with minimum of a 90-day history that tracks all events related to system use; specifically, who, what, where and when.
      7) NVR management capability providing automatic video routing to a back-up spare recorder in case of failure.
      8) Accessible locally and remotely via the internet, intranet, or a Mobile Device.
      9) Records all alarm events in real time, ensuring 60 seconds before and after the event are included in the recording.

10) Utilize network connections for integration with the VMS computer station.
11) Allow for independently adjustable frame rate settings.

d. The NVR shall support the following network protocols:
   1) RTP, Real Time Streaming Protocol (RTSP), UDP, TCP/IP, HTTP, Simple Network Management Protocol (SNMP), DHCP, and ARP.
   2) Video Display: H.264, M-JPEG in server push mode only.
   3) Have the ability to adjust bandwidth, image quality and image rate.
   4) Support image sizes of up to 15 Mega-Pixel.
   5) Have an audio coding format of G.711 or G.728.
   6) Provide a streaming video frame rate of at least 10 images per second per camera.
   7) Have an adjustable Maximum LAN Data Rate that can be set to variable or constant.

e. All connections within the system shall be via CAT6 cable and RJ-45 jacks. If analog equipment is used as part of the system, then an encoder will be utilized to convert the analog signal to a digital one.

f. The network video recorder shall have the capability to record up to 128 IP cameras simultaneously.

g. Server Technical Characteristics:

Hardware	Commercial grade computer
CPU	Core I7 3.86 GHz or better
Hard Disk Interface	SATA
RAM	16 GB minimum
OS	Windows 10 Enterprise / Windows Server 2019
Graphics Display	(2) DVI or HDMI Out with 2GB dedicated Ram
Ethernet Card	100/1000 Base-T
HDD Capacity	32 TB

7. A CCTV System network shall be comprised of:
   a. System Server(s).
   b. Computer Workstation(s) One work stations to be supplied with 24 inch monitor.
   c. Recording Device(s)
   d. Encoder/Decoder(s)
   e. Monitor(s)
   f. Network Switches
   g. Router
   h. Other network appliances as required
      1) Shall provide overall control, programming, monitoring, and recording of all cameras and associated devices within the CCTV System.
      2) All equipment on the network shall be IP addressable.
   i. Network Switch Technical Characteristics

Protocol and standard	IEEE802.3at

Ports	(48)100/1000M auto-negotiation RJ-45 ports with auto MDI/MDI-X, (4) GBIC
Network media	CAT6 UTP for 1,000Mbps
Transmission method	store-and-forward
LED	indicator power, act/link, speed

j. Router Technical Characteristics

Network Standards	IEEE 802.3at 1000Base-T Ethernet (LAN) IEEE 802.3x Flow Control IEEE802.1p Priority Queue ANS/IEEE 802.3 NWay auto-negotiation
Protocol	TCP/IP, UDP, PPPoE, AND DHCP (client and server)
VPN Supported	PPTP, IPSec pass-through
Management	Browser
Ports	8 x 100/1000Base-T Auto sensing RJ45 ports, and (2) GigaBit Interface Converter ports (GBIC)
LEDs	Power, Activity, LAN Link (100/1000)

Q. Wires and Cables
1. Shall meet or exceed the manufactures recommendation for power and signal.
2. Category cabling will be installed by SECURITY Contractor.
3. Conduit fills shall not exceed 40 percent unless otherwise documented.
4. A pull string shall be pulled along and provided with signal and power cables to assist in future installations.
5. At all locations where there is a wall penetration or core drilling is conducted to allow for conduit to be installed, fire stopping materials shall be applied to that area
6. High voltage and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High voltage for the security system shall be defined as any cable or sets of cables carrying 50 VDC/VAC or higher.
7. For all equipment that is carrying digital data between the Access Control System and Database Management or at a remote monitoring station, shall not be less than CAT6.
8. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines, terminating at exterior devices, shall include surge protection. Surge protection shall be furnished at the equipment end and shall be installed within three (3) ft. (one (1) m.) of the building cable entrance.
9. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. Fuses and relays shall not be used as a means of surge protection.

10. Outside Plant CAT6 cabling w/ Sch40 conduit raceway (1" Min) for all site pathways. The use of Building entrance terminals for all site devices entering the facility.
11. Signal Cables:
    a. Signal wiring for IP cameras utilizing Power over Ethernet (POE) shall be Category 6 (CAT6) cable.
    b. If the camera is up to 300 ft from a switch or POE power supply, The cable will comply with the Power over Ethernet, IEEE802.3at, Standard.
    c. If the camera is over 300 ft from a network switch then utilize a multimode fiber optic cable with a minimum size of 50 microns.
    d. When Fiber Optic cable is indicated then provide a separate twisted pair copper cable for power appropriate for the distance and power requirements.
    e. CAT6 Technical Characteristics:

Number of Pairs	4
Total Number of Conductors	8
AWG	23
Stranding	Solid
Conductor Material	BC - Bare Copper
Insulation Material	Plenum
Overall Nominal Diameter	.380 in.
IEC Specification	11801 Category 6
TIA/EIA Specification	568-B.2 Category 6
Max. Capacitance Unbalance	(pF/100 m) 46 pF/100 m
Nom. Velocity of Propagation	68 %
Max. Conductor DC Resistance	20 Ohms/1000ft

    f. Fiber Optic Cables Technical Characteristics:

Fiber Type	50 Micron
Number of Fibers	2
Core Diameter 6	2.5 +/- 2.5 microns
Core Non-Circularity	5% Maximum
Clad Diameter	125 +/- 2 microns
Clad Non-Circularity	1% Maximum
Core-clad Offset	1.5 Microns Maximum
Primary Coating Material	Acrylate
Primary Coating Diameter	245 +/- 10 microns
Secondary Coating Material	Engineering Thermoplastic
Secondary Coating Diameter	900 +/- 50 microns
Strength Member Material	Aramid Yarn
Outer Jacket Material	PVC
Outer Jacket Color	Orange
Overall Diameter	.200 in.
Numerical Aperture	.275

Maximum Gigabit Ethernet	300 meters
Maximum Gigabit Ethernet	550 meters

12. High Voltage Power Cables
    a. Will be sized accordingly and shall comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive polyvinylchloride (PVC) jacket.
    b. High Voltage Cables will be utilized for all components of the CCTV System that require either a 110 VAC 60 Hz or 220 VAC 50 Hz input. Each feed will be connected to a dedicated circuit breaker at a power panel that is primarily for the security system.
    c. All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used as a means of surge protection.
13. Low Voltage Power Cables
    a. Shall be a minimum of 16 AWG, stranded, and have a polyvinylchloride outer jacket.
    b. Cable size shall be determined using a basic voltage over distance calculation and shall comply with the NEC's requirements for low voltage cables.

2.4 INSTALLATION KIT

R. General:
1. The kit shall be provided that, at a minimum, includes all connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware shall be turned over to the Contracting Officer. The following sections outline the minimum required installation sub-kits to be used:
2. System Grounding:
    a. The grounding kit shall include all cable and installation hardware required. All head end equipment and power supplies shall be connected to earth ground via internal building wiring, according to the NEC.
    b. This includes, but is not limited to:
        1) Control Cable Shields
        2) Data Cable Shields
        3) Equipment Racks
        4) Equipment Cabinets
        5) Conduits
        6) Cable Duct blocks
        7) Cable Trays
        8) Power Panels
        9) Grounding
        10) Connector Panels

3. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
4. Conduit, Cable Duct, and Cable Tray: The kit shall include all conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, and/or cable tray installation in accordance with the NEC and this document.
5. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
6. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to correctly label each subsystem according to the OEM requirements, as-installed drawings, and this document.
7. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to correctly provide the system documentation as required by this document and explained herein.

PART 3

3.1 INSTALLATION

A. System installation shall be in accordance with NECA 303, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.

B. Components shall be configured with appropriate “service points” to pinpoint system trouble in less than 30 minutes.

C. The Contractor shall install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

D. The CCTV System will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand-alone or a complete network.
    a. Security Access Detection:
        1) Record cameras on a 24 hours basis @ 7.5 fps Alarm at 15 fps.

E. Integration with these security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.

F. For programming purposes refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.

G. A complete CCTV System shall be comprised of, but not limited to, the following components:
    1. Cameras
    2. Lenses

3. Video Display Equipment
4. Camera Housings and Mounts
5. Controlling Equipment
6. Recording Devices (Exisitng)
7. Wiring and Cables

H. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.

I. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.

J. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

K. Interconnection of Console Video Equipment: The Contractor shall connect signal paths between video equipment as specified by the OEM. Cables shall be as short as practicable for each signal path without causing strain at the connectors. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.

L. Cameras:
1. Install the cameras with the focal length lens as indicated for each zone.
2. Connect power and signal lines to the camera.
3. Set cameras with fixed iris lenses to the f-stop to give full video level.
4. Aim camera to give field of view as needed to cover the alarm zone.
5. Aim fixed mounted cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun.
6. Focus the lens to give a sharp picture (to include checking for day and night focus and image quality) over the entire field of view; and synchronize all cameras so the picture does not roll on the monitor when cameras are selected. Dome cameras shall have all preset positions defined and installed.

M. Monitors:
1. Install the monitors as shown and specified in design and construction documents.
2. Connect all signal inputs and outputs as shown and specified.
3. Terminate video input signals as required.
4. Connect the monitor to AC power.

N. Video Recording Equipment:
1. Install the video recording equipment as shown in the design and construction documents, and as specified by the OEM.

2. Connect video signal inputs and outputs as shown and specified.
3. Connect alarm signal inputs and outputs as shown and specified.
4. Connect video recording equipment to AC power.

O. Video Signal Equipment:
1. Install the video signal equipment as shown in the design and construction documents, and as specified by the OEM.
2. Connect video or signal inputs and outputs as shown and specified.
3. Terminate video inputs as required.
4. Connect alarm signal inputs and outputs as required.
5. Connect control signal inputs and outputs as required
6. Connect electrically powered equipment to AC power.

P. Camera Housings, Mounts, and Poles:
1. Install the camera housings and mounts as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each camera, housing and mount with maximum wind and ice loading encountered at the site.
2. Provide a foundation for each camera pole as specified and shown.
3. Provide a ground rod for each camera pole and connect the camera pole to the ground rod as specified in Division 26 of the Master Specification and the Electrical Manual 730.
4. Provide electrical and signal transmission cabling to the mount location via a hardened carrier system from the Access Control System and Database Management to the device.
5. Connect signal lines and AC power to the housing interfaces.
6. Connect pole wiring harness to camera.

Q. Power:

Electrical power for cameras, DVR's and monitors must be supplied from an emergency power circuit or new installations, an uninterruptible/power supply. The UPS supplied must support the cameras, the monitors and the recorders during an alarm state.

R. System Start-Up
1. The Contractor shall not apply power to the CCTV System until the following items have been completed:
   a. CCTV System equipment items and have been set up in accordance with manufacturer's instructions.
   b. A visual inspection of the CCTV System has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
   c. System wiring has been tested and verified as correctly connected as indicated.
   d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
   e. Power supplies to be connected to the CCTV System have been verified as the correct voltage, phasing, and frequency as indicated.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

S. Supplemental Contractor Quality Control

1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed CCTV System; and are approved by the Contracting Officer.
2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

3.2 TESTING AND TRAINING

T. All testing and training shall be compliant with the General Requirements, Section 01 0000, GENERAL REQUIREMENTS.

END OF SECTION 282300

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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. Air-sampling smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Device guards.
8. Magnetic door holders.
9. Remote annunciator.
10. Addressable interface device.
11. Digital alarm communicator transmitter.
12. 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.

F. VESDA: Very Early Smoke-Detection Apparatus.

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. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.

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. 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. Air-sampling smoke-detection system (VESDA).
6. Automatic sprinkler system water flow.
7. Preaction system.
8. Fire-extinguishing system operation.
9. Fire standpipe system.
10. 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. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Activate preaction system.
10. Recall elevators to primary or alternate recall floors.
11. Activate elevator power shunt trip, after return of elevators to designated floors.
12. Activate emergency lighting control.

13. Activate emergency shutoffs for gas and fuel supplies.

14. Record events in the system memory.

15. 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: Provide products by the following:

1. Silent Knight by Honeywell. Installed by Approved DFCM installers only.

2. Fire-Lite Alarms, Inc. A Honeywell International company. Installed by Approved DFCM installers only.

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 75% of manufacturers maximum quantity of 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 232 port for PC configuration.

c. 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. 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.

G. 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.

H. 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.

I. 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.

J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

K. 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.

L. 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.

M. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed, valve-regulated, recombinant lead acid.

N. 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. Factory finish: white.

7. 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.

7. Duct detectors shall be installed in readily accessible locations. If a duct detector cannot be installed in a readily accessible location, these shall be equipped with remote indicating lamps per NFPA 72.

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 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.10 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.

2. Factory finish: white.

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.

2.11 AIR-SAMPLING SMOKE DETECTOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fenwal Protection Systems; A UTC Fire & Security Company.

2. Xtralis Pty Ltd.

B. General Description:

1. Air-sampling smoke detector shall be laser based using a piping system and a fan to transport the particles of combustion to the detector.

2. Provide two levels of alarm from each zone covered by the detector and two supervisory levels of alarm from each detector.

3. The air being sampled shall pass through filters to remove dust particulates greater than 20 microns before entering the detection chamber.

4. Detectors shall have the capability via RS 485 to connect up to 100 detectors in a network.

5. Detectors shall communicate with the fire-alarm control unit via addressable, monitored dry contact closures, RS 485, and interface modules. Provide a minimum of six relays, individually programmable remotely for any function.

6. Pipe airflow balancing calculations shall be performed using approved calculation software.

C. Detector:

1. Detector, Filter, Aspirator, and Relays: Housed in a mounting box and arranged in such a way that air is drawn from the detection area and a sample passed through the dual-stage filter and detector by the aspirator.

2. Obscuration Sensitivity Range: 0.005 - 6 percent obs/ft..

3. Four independent, field-programmable, smoke-alarm thresholds per sensor pipe and a programmable scan time delay. The threshold set points shall be programmable.

a. The four alarm thresholds may be used as follows:

1) Alarm Level 1 (Alert): Activate a visual and an audible supervisory alarm.

2) Alarm Level 2 (Action): Activate shutdown of electrical/HVAC equipment and activate a visual and an audible supervisory alarm.

3) Alarm Level 3 (Fire 1): Activate building alarm systems and initiate call to fire response unit.

4) Alarm Level 4 (Fire 2): Activate suppression system or other countermeasures.

b. Final Detection System Settings: Approved by Owner.

c. Initial Detection Alarm Settings:

1) Alarm Level 1 (Alert): 0.08 percent obs/ft..

2) Alarm Level 2 (Action): 1.0 percent obs/ft..

3) Alarm Level 3 (Fire 1): 2.0 percent obs/ft..

4) Alarm Level 4 (Fire 2): 4.0 percent obs/ft..

4. Power Supply:

a. Regulated 24-V dc, monitored by the fire-alarm control unit, with battery backup.

b. Battery backup shall provide 24 hours' standby, followed by 30 minutes at maximum connected load.

5. Detector shall also transmit the following faults:

    a. Detector.

    b. Airflow.

    c. Filter.

    d. System.

    e. Zone.

    f. Network.

    g. Power.

6. Provide four in-line sample pipe inlets that shall contain a flow sensor for each pipe inlet. The detector shall be capable of identifying the pipe from which smoke was detected.

7. Aspirator: Air pump capable of allowing for multiple sampling pipe runs up to 650 feet (200 m) in total, (four pipe runs per detector) with a transport time of less than 120 seconds from the farthest sample port.

8. Air-Sampling Flow Rates Outside Manufacturer's Specified Range: Result in a trouble alarm.

9. Provide software-programmable relays rated at 2 A at 30-V dc for alarm and fault conditions.

10. Provide built-in event and smoke logging; store smoke levels, alarm conditions, operator actions, and faults with date and time of each event. Each detector (zone) shall be capable of storing up to 18,000 events.

11. Urgent and Minor Faults. Minor faults shall be designated as trouble alarms. Urgent faults, which indicate the unit may not be able to detect smoke, shall be designated as supervisory alarms.

D. Displays:

1. Include display module within each detector.

2. Each display shall provide the following features at a minimum:

    a. A bar-graph display.

    b. Four independent, high-intensity alarm indicators (Alert, Action, Fire 1, and Fire 2), corresponding to the four alarm thresholds of the indicated sector.

    c. Alarm threshold indicators for Alert, Action, and Fire 1.

    d. LED indication that the first alarm sector is established.

e. Detector fault and airflow fault indicators.

f. LED indicators shall be provided for faults originating in the particular zone (Zone Fault), faults produced by the overall smoke-detection system, and faults resulting from network wiring errors (Network Fault).

g. Minor and urgent LED fault indicators.

E. Sampling Tubes:

1. Smooth bore with a nominal 1-inch (25-mm) OD and a 7/8-inch (21-mm) ID. Sampling pipe with between 5/8- and 1-inch (15- and 25-mm) ID can be used in specifically approved locations when recommended by manufacturer.

2. Pipe Material: CPVC and complying with UL 1887, "Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics."

3. Joints in the sampling pipe shall be airtight. Use solvent cement approved by the pipe manufacturer on all joints except at entry to the detector.

4. Identify piping with labels reading: "Aspirating Smoke Detector Pipe - Do Not Paint or Disturb" along its entire length at regular intervals according to NFPA 72.

5. Support pipes at not more than 60-inch (1520-mm) centers.

6. Fit end of each trunk or branch pipe with an end cap and drilled with a hole appropriately sized to achieve the performance as specified and as calculated by the system design.

F. Sampling Holes:

1. Sampling holes of 5/64 inch (2 mm), or other sized holes per manufacturer's written instructions, shall be separated by not more than the maximum distance allowable for conventional smoke detectors. Intervals may vary according to calculations.

2. Follow manufacturer's written recommendations to determine the number and spacing of sampling points and the distance from sampling points to ceiling or roof structure and to forced ventilation systems.

3. Each sampling point shall be identified by an applied decal.

2.12 NOTIFICATION APPLIANCES

A. 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.

B. 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. Factory finished, white.

C. 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.

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 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.

2.15 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.

2.16 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.

2.17 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements and requirements in NFPA 72.

2.18 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. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.

H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

I. 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.

J. 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.

K. 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.

L. 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.

M. 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 dyas in ad

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

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Removing existing vegetation as indicated on demolition plan.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.
4. Removing above and below-grade site improvements.
5. Disconnecting, capping or sealing, abandoning site utilities in place, and removing site utilities.
6. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security, protection facilities, and temporary erosion and sedimentation control procedures.
2. Division 02 Section "Selective Site Demolition" for demolition of buildings, structures, and site improvements.
3. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain on Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site. Stripped topsoil shall only be removed from the property upon approval from the Owner.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, according to Division 01 Section "Project Record Documents," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control Drawings, a sediment and erosion control plan, specific to the site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

E. Removal of underground utilities is included in Division 21, Division 22, Division 26, Division 27, and Division 28 Sections covering site utilities.

3.4 CLEARING AND GRUBBING

A. Remove obstructions such as shrubs, grass, and other vegetation to permit installation of new construction.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove top 1-2" of soil including all weeds, grass, brush and other vegetation and haul this material off-site before stripping topsoil. Actual depth of soil removal from site may vary depending on the amount of roots and plant material in the top 1-6" of soil. The base bid shall be to strip up to 3" of soil, etc. from the site and dispose of it off-site. Consult with Landscape Architect on-site prior to stripping soil so that a visual inspection can be done. Contractor shall review the topsoil report already completed with the Landscape Architect at this meeting. See appendix 'A' for topsoil report.

B. Strip only from 3" depth to 12" depth (the first 1-3" being disposed off of-site) of topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials. This depth of topsoil stripping may need to be modified based on the results of the topsoil test noted above and also based on observations at the meeting to be held on-site as discussed above. The contractor shall calculate how much soil is needed for the lawn areas and planter areas and then only needs to strip that much soil (less the amendments).

1. Remove subsoil and non-soil materials from topsoil by screening all topsoil from trash, debris, weeds, roots, and other waste materials greater than ½ inch in any dimension.

2. Amount of topsoil that needs to be stockpiled shall be determined by the following:

    a. Strip all soils under buildings, structures, hardscaped/paved areas per civil, architectural, mechanical and structural drawings.
    b. Strip enough topsoil based on quantity needed to install 4" depth of amended soil in lawn areas and 12" depth of amended soil in planter areas.
    c. Topsoil depths in lawn and planter areas may be deeper than noted if at no additional cost to the Owner.

C. Stockpile stripped topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to 6 feet.

2. Do not stockpile topsoil within tree protection zones.

3. Minimize overworking of topsoil so that physical properties of topsoil are retained. Topsoil should be stripped and piled in a location that will not interfere with construction. Topsoil shall not be moved from location to location. Topsoil shall not be driven over with any equipment. Overworking of topsoil may invalidate the reuse of it for landscaping purposes. If topsoil is unusable due to overworking it, moving it, driving over it unnecessarily, etc, contractor shall at his own expense import topsoil to replace damaged topsoil as required. Contractor shall also bear the expense of disposal of any unusable stripped topsoil. Landscape contractor shall provide a second soils test for stockpiled topsoil prior to reuse in landscaped areas. Adjustments may need to be made to amendments depending on results of topsoil test.

4. Dispose of excess topsoil as specified for waste material disposal as directed by the Owner. Owner retains all rights to stripped topsoil. Owner shall approve any removal of stripped topsoil from site however the contractor shall bear the cost to remove such soil as approved by the Owner.

5. Stockpile surplus topsoil to allow for landscaping per plans. Depths of topsoil in lawn areas can be deeper than what is specified if excess soils are available for the extra depths, however, the Civil engineer must approve this and determine that all grading and drainage requirements can still be met by having deeper topsoil depths in lawn areas. Consult with Owner and Civil Engineer on-site prior to site work to discuss this and determine appropriate course of action to be taken.

3.6 SITE IMPROVEMENTS

A. Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction. Refer to project plans for improvements to be abandoned in place.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION

SECTION 31 2000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses and exterior plants.

2. Subbase course for concrete walks and pavements.

3. Subbase and base course for asphalt paving.

4. Subsurface drainage backfills for walls and trenches.

5. Excavation and backfilling for buildings and structures.

6. Excavation and backfilling for utility trenches.

B. Related Sections include the following:

1. Division 1 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities.

2. Division 2 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

3. Division 2 Section "Dewatering" for lowering and disposing of ground water during construction.

4. Division 2 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.

5. Division 2 Section "Exterior Plants" for planting bed establishment and tree and shrub pit excavation and planting.

6. Division 3 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by an independent geotechnical testing agency, according to ASTM D 1586.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

M. Structural fill: Is fill material that will ultimately be subjected to any kind of structural loading, such as those imposed by footings, floor slabs, pavements, etc...

1.3 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.

B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.

2. Laboratory compaction curve according to ASTM D 1557 for each on-site and borrow soil material proposed for fill and backfill.

C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.4 QUALITY ASSURANCE

A. Preexcavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.

3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations. Use imported structural fill for structurally loaded areas and pavements. All earthwork shall be in accordance with the project geotechnical study.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Imported Structural Fill and Backfill: Naturally occurring or artificially graded mixture of sands and gravels, free of organics, vegetation, sod, trash, frozen materials, clay clods or other deleterious materials such as trash, frozen clods, clay clods, etc., with 100% passing the 4" sieve, 70-100% passing the No. ¾" sieve, 40-80% passing the No. 4 sieve, 15-50% passing the No. 40 sieve, 0-20% material passing the No. 200 Sieve. Liquid Limit is set at 35 max and Plasticity Index is set at 15 max. Structural Fill should be well-graded and generally with a maximum particle size of 4 inches. Onsite clay soils are not too used as part of structural fill. However, the native gravel soils appear to be suitable for use as placed and compacted structural fill provided the material meets the requirements for structural fill and any existing debris and particles larger than 6 inches in diameter are removed prior to use.

E. Granular Imported Structural Fill and Backfill for Soft Areas: Soft spots to be removed and replaced with granular material for a minimum depth of 24 inches as indicated in the geotechnical report. Naturally occurring or artificially graded mixture of sands and gravels, free of organics, vegetation, sod, trash, frozen materials, clay clods or other deleterious materials such as trash, frozen clods, clay clods, etc., with material passing the No. 200 Sieve limited to 15 percent fines (based on the minus 3/4 inch fraction), well-graded and generally with a maximum particle size of 3 inches , but with occasional permissible particles up to 6 inches provided that they do not result in "honeycombing" or preclude achieving the required degree of compaction. The fines plasticity index shall be less than 15 and liquid limit less than 35.

F. Base Course at all Site Concrete Work: Sound, crushed, or uncrushed rock or gravel and sand, well graded as follows: (refer to UDOT specs for base course.)

Sieve	% by Weight Passing Sieve
1 1/2"	100
1"	90 -100
¾"	70 – 85

½"	60 – 80
3/8"	55 – 75
#4	40-65
#16	25 – 40
#200	7 – 11 (non-plastic)

Provide a 4-inch minimum of base course material beneath all site concrete work.

G. Site Grading Fill: Placed over larger areas to raise the site grade. Sandy to gravelly soils with a max particle size of 6" and a min 70% passing ¾" sieve and max 50% passing no 200 sieve. Onsite clay soils are not to be used as part of grading fill.

H. Bedding Course: Type A-1-a or A-1-b (AASHTO Classifications soils per city requirements.)

I. Drainage Course: Narrowly graded mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve. Provide a minimum of 4-inch depth under all concrete building slab areas or as shown on plans.

J. Cobble Material: Naturally or artificially graded mixture of angular rock. 4" to 12" in diameter.

K. Drain Rock: For Fill in submerged area 3" Minus washed rock and pea gravel material with 0-25 passing the No 10, 0-15 passing the No 40 and 0-5 passing the No 200 Non-Plastic should be used. If free draining fill is adjacent to soil containing a significant amount of sand or silt/clay, precautions should be taken to prevent the migration of fine soil into the free drain fill. This would include the use of filter fabric between the two soil types. Fabric to be approved by geotechnical engineer.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.

2. Yellow: Gas, oil, steam, and dangerous materials.

3. Orange: Telephone and other communications.

4. Blue: Water systems.

5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.

D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Pump ground water out of excavations and dispose of ground water in accordance with City requirements.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A. Explosives: The use of explosives is NOT allowed, unless specifically permitted by City Officials.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections. Refer to geotechnical report for the over excavation and depth of required structural fill for footing.

1. Excavations for Footings and Foundations: – We recommend that conventional strip and spread foundations be constructed entirely on firm, undisturbed, uniform sand or gravel soils or entirely on a minimum of 18 inches of properly placed, compacted, and tested structural fill extending to undisturbed native gravel soils. Review excavation and gravel thickness with the Owners geotechnical engineer prior to proceeding with other work. The bottom of footing excavations should be compacted with at least 4 passes of a non-vibratory roller prior to erection of forms or placement of structural fill to densify soils that may have been loosened during excavation and to identify soft spots. If soft areas are encountered, they should be stabilized as recommended in in geotechnical report. If soft areas are encountered at the base of any excavations, the soft areas will be excavated 24 inches minimum and backfilled with structural fill for soft areas. The width of the excavations to extend one foot horizontally beyond the footing perimeter for each two feet of vertical over excavation. Review excavation with Owners geotechnical engineer prior to backfill. Trim bottoms to required lines and grades to leave solid base to receive other work.

   Structural fill used below foundations should extend laterally a minimum of 6 inches for every 12 vertical inches of structural fill placed. For example, if 24 inches of structural fill is required to bring the excavation to footing grade, the structural fill should extend laterally a minimum of 9 inches beyond the edge of the footings on both sides.

2. Excavation for Underground Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces except to compact subgrade to 90% maximum laboratory density as determined by ASTM D 1557 or the percentage as indicated on plans. All utility system structures shall have a minimum of 8" compacted bedding or base course under the bottom of the structure.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrade. Any non-native soils that do not meet the requirements laid out in the owner's geotechnical report will be completely removed below any new pavement and backfilled with imported structural fill for soft areas. Proof roll as outlined in this section prior to placement of other work. As indicated in the geotechnical report concrete flatwork and slabs can be placed on undisturbed native soils after appropriate removals and grading.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

1. Excavate trenches 12 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

2. Excavate 16 inches minimum deeper than the elevation required for utilities that are to be placed at or near ground water (within 12 inches of ground water) and backfill with 12" min of drainage rock for pipe stabilization. Place drainage fabric over drainage rock prior to placement of pipe bedding material. Wrap the pipe zone material in drainage fabric if the pipe is below ground water level. Coordinate with City inspector if additional measures are required for utility support.

3.8 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. DO not route construction traffic over subgrade.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work. Soft spots caused by routing

construction equipment over subgrade will be repaired without additional compensation.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

2. Surveying locations of underground utilities for Record Documents.

3. Testing and inspecting underground utilities.

4. Removing concrete formwork.

5. Removing trash and debris.

6. Removing temporary shoring and bracing, and sheeting.

7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with bedding course material; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete Miscellaneous Cast-in-Place Concrete."

D. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

E. Place and compact final backfill of satisfactory soil to final subgrade elevation.

F. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use approved native soil material or imported fill.

2. Under walks and pavements, use approved native granular material or imported structural fill.

3. Under steps and ramps, use engineered fill.

4. Under building slabs or site pavement, use structural fill.

5. Under footings and foundations, use structural fill.

6. Under utility lines and utility structures, use bedding course material

7. Pipe zone (bottom of pipe to 1 foot over the top of pipe), use bedding course material

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, compact each layer of backfill or fill soil material at 95 percent. If there is greater than 5 feet of fill below structurally loaded areas compact to 98 percent.

2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.

3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.

4. For utility trenches, refer to City standards for utility trenching. All fill and compaction in utility trenches both onsite and offsite must meet these requirements.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus, or minus 1 inch.

2. Walks: Plus, or minus 1/2 inch.

3. Pavements: Plus, or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBBASE AND BASE COURSES

A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:

1. Place base course material over subbase course under hot-mix asphalt pavement.

2. Shape subbase and base course to required crown elevations and cross-slope grades.

3. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

4. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.18 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick. Compact over drainage piping with 4 passes of smooth drum roller as required by pipe manufacture.

2. Compact drainage course material using 4 passes of a smooth drum 5-ton vibratory roller or equivalent each layer to required thickness.

3.19 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.

2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.

3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

DFCM REGIONAL CENTER - FARMINGTON
577 N LAGOON DRIVE
FARMINGTON, UT 84025

SECTION 32 1216 - HOT-MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Asphalt paving.

2. Pavement-marking.

B. Related Sections include the following:

1. Division 2 Section "Earthwork" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. DOT: Department of Transportation.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of state or local DOT.

1. Standard Specification: Comply with APWA specifications, Latest edition, and with local governing regulations of more stringent than herein specified.

2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Qualification Data: For manufacturer.

D. Material Test Reports: For each paving material.

E. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state of Utah.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.

C. The OWNER will engage materials testing service for quality control during base and asphalt placement operations.

D. Contractor Responsibility for Testing: Advise testing agency sufficiently in advance of operations to allow for completion of quality tests, and for assignment of personnel.

Deliver samplers of proposed base materials to testing agency for analysis and approval.

Assist testing agency representative to safely have access to the site during placement operations

E. Frequency of Tests: Owner's testing agency will be instructed to conduct field density tests of materials as follows:

Aggregate Base Course: Conduct one test for each 1000 square feet of each lift of material completed to 95% minimum of maximum dry density determined b ASTM D 1557-78.

Asphaltic Surface Course: Conduct one test for each 1000 square feet of material compacted to 96% minimum of design density as determined by ASTM D 1559-78 (Marshall Method).

F. Grade Control: Establish and maintain required lines and elevations. Lay base course within plus or minus 1/4 inch in 10 feet of required elevations.

G. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Tack Coats: Minimum surface temperature of 60 deg F.

2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.

3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or properly cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Cement: ASTM D 3381 for viscosity-graded material, use AC-10. ASTM D 6373 for penetration-graded material, use PG 58-22 or PG58-28 per current APWA Specifications.

B. Tack Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Water: Potable.

D. Undersealing Asphalt: ASTM D 3141, pumping consistency.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Pavement – Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time less than 3 minutes.

1. Color: White, Yellow, Red, and Blue as indicated

2. White for parking stripes

3. Yellow for safety markings.

4. Reflective white for crosswalks. White and blue for international accessibility symbols.

5. Red for curb marking, where indicated.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:

1. Provide mixes to comply with the APWA Standards.

2. 1/2-inch aggregate for parking areas, playgrounds and access roadways.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.

2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide formulated by manufacturer for that purpose.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.

2. Place hot-mix asphalt surface course in single lift.

3. Spread mix at minimum temperature of 250 deg F.

4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.

5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.

3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."

5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent nor greater than 100 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

3.7 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.

2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.

2. Surface Course: 1/8 inch.

3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on-site.

END OF SECTION

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SECTION 32 1313 - SITE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Driveways and concrete pads
2. Curbs and gutters
3. Walkways

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete pavement mixture.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94 requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type II, gray.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source.

C. Water: ASTM C 94.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: ASTM C 494, of type suitable for application, certified by manufacturer to be compatible with other admixtures and to contain no more than

0.1 percent water-soluble chloride ions by mass of cementitious material.

2.2 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

2.3 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.4 STEEL REINFORCEMENT

A. Epoxy-Coated Reinforcing Bars: ASTM A 615, Grade 60, deformed bars, ASTM A 775, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

B. Bar Supports: bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars or dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice".

2.5 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:

1. Compressive Strength (28 Days): 4000 psi.

2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.

3. Slump Limit: 4 inches, plus or minus 1 inch.

4. Air Content: 6-1/2 percent plus or minus 1.5 percent.

5. Cement: 6-1/2 bag mix.

2.6 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Furnish batch certificates for each batch discharged and

used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to require lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement embedded in concrete flatwork.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edging true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness to match jointing of existing adjacent concrete pavement.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial

floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed pavement surfaces with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

A. Comply with ACI 306.1 for cold-weather protection.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or

windy conditions cause moisture loss approaching 0.2 lb/sq. Ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screening, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these methods.

3.8 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

Elevation: 1/4 inch.

Thickness: Plus 3/8 inch, minus 1/4 inch.

Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4 inch.

Joint Spacing: 3 inches.

Contraction Joint Depth: Plus 1/4 inch, no minus.

Joint Width: Plus 1/8 inch, no minus.

3.9 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement.

C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

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SECTION 32 1373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.

2. Hot-applied joint sealants.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, eight, Samples of materials that will contact or affect joint sealants. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples: For each kind and color of joint sealant required.

C. Pavement-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.

2. Joint-sealant manufacturer and product name.

3. Joint-sealant formulation.

4. Joint-sealant color.

D. Product certificates.

E. Product test reports.

F. Preconstruction compatibility and adhesion test reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021.

B. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Crafco Inc., an ERGON company; RoadSaver Silicone.

b. Dow Corning Corporation; 888.

c. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Crafco Inc., an ERGON company; RoadSaver Silicone SL.

b. Dow Corning Corporation; 890-SL.

c. Pecora Corporation; 300 SL.

C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pecora Corporation; Urexpan NR-200.

2.

2.3 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Crafco Inc., an ERGON company; Superseal 444/777.

B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Meadows, W. R., Inc.; Sealtight Hi-Spec or Sealtight 3405.

b. Right Pointe; D-3405 Hot Applied Sealant.

2.

2.4 JOINT-SEALANT BACKER MATERIALS

A. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Cleaning of Joints: Clean out joints immediately before installing joint sealants.

C. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

D. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.

2. Do not stretch, twist, puncture, or tear joint-sealant backings.

3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place joint sealants so they directly contact and fully wet joint substrates.

2. Completely fill recesses in each joint configuration.

3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.

2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

G. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

H. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION

SECTION 32 8000 - LANDSCAPE IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall construct an automatic irrigation system, complete and operable, in accordance with the requirements of the Contract Documents.

B. Said irrigation system shall include but not be limited to all pipes, fittings, irrigation heads, drip line, valves, automatic control valves, controllers, valve boxes, drain valves, quick coupler valves, operating wrenches, riser assemblies, direct burial wires, electrical connections, wiring and other appurtenances, piping, connections, testing, cleaning-up, maintenance and adjustments necessary for a complete operating system, ready for immediate use upon completion. Minor items necessary for proper construction and functional operation of this system, not specifically described in the Contract Documents, shall be included as a part of the work of this Section.

C. The Section cross references the following sections:
   1. Division 01 Section "Contractor Submittals"
   2. Division 32 "Landscape Planting"
   3. Division 22 "Plumbing"

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein, are as specified in Division 01.

B. Commercial Standards:

ASTM B 3	Specification for Soft or Annealed Copper Wire
ASTM D2564	Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings
AWWA C 500	Gate Valves for Water and Sewerage Systems

1.3 CONTRACTOR SUBMITTALS

A. Manufacturer's literature, samples (where requested by the LANDSCAPE ARCHITECT, HERE IN REFERRED TO AS L.A.), and installation instructions shall be submitted in accordance with Division 01 Section "Contractor Submittals."

B. Record drawings, showing actual locations of all valves, pipes (lines), heads, dimensions, controllers, control lines, and electrical wires shall be submitted prior to final inspection. Diagrammatic location of irrigation system components is not acceptable when submitting record drawings – actual location of irrigation system equipment is required for locating in the field.
   1. Actual routing of mainline with dimensions from fixed points.
   2. Actual routing of control wiring with dimensions from fixed points.

3. Location of wire splices (must be placed in valve box and only used splices in approved locations)
4. Actual routing of lateral lines and head locations
5. Actual location of valve boxes with notes on type of valve used at each location.
6. Actual location of sleeves with dimensions from fixed points.
7. Actual location of stubbed mainlines or lateral lines (if applicable)
8. Actual location of sensors and associated wiring (i.e. rain gauge, ET sensors, etc.)
9. Provide legend of symbols/notes used on record drawings.
10. Any other notes as necessary to enable the owner to understand and locate irrigation system equipment in the field upon completion of the project.

C. Equipment for Operation: The CONTRACTOR shall provide the following equipment, in addition to what is indicated on the Drawings.
   1. One Gate valve key. Valve key should be T-handle style, 5ft. min. length, rigid steel.
   2. Two keys for locking valve boxes.
   3. 2 Valve Keys for Quick Coupler – coordinate with Owner.
   4. One Valve Key for Manual Drain Valve.

D. A reduced copy of the irrigation plan shall be laminated and mounted in the controller.

1.4 QUALITY ASSURANCE

A. In addition to other inspections, as provided by the L.A. and or OWNER, the CONTRACTOR shall give at least 72 hours notice to the L.A. for scheduling the following special inspections:
   1. Layout of the system (prior to trenching)
   2. Inspection of trenches, backfilling, and equipment.
   3. Pressure tests
   4. Coverage adjustment
   5. Automatic operation
   6. Water audit

B. The CONTRACTOR shall notify the L.A. at least 72 hours prior to performing the tests. All tests shall be performed in the presence of the L.A. Test requirements shall be as follows:
   1. All main lines shall be capped and pressure tested at 125 P.S.I. for a period of 4 hours. Any leaks shall be corrected by removing the leaking pipe or fittings and installing new material in its place. Repeat pressure test as required to assure absence of leaks.
   2. The contractor shall not allow nor cause any of his work to be covered until it has been inspected, tested, and approved by the L.A.
   3. Where main line will be allowed to sit uncovered for any length of time in the trench prior to testing, shade main line with a thin covering of soil to minimize weather-related expansion or contraction of pipe.
   4. When the irrigation system is completed, the CONTRACTOR, in the presence of the L.A., shall perform test coverage of water afforded the lawn and

planting areas. The CONTRACTOR shall furnish all material and perform all work required to correct any inadequacies of coverage disclosed. The CONTRACTOR shall inform the L.A. of any deviation from the Drawings required due to wind, planting, soil, or site conditions that bear on proper coverage.

5. Upon completion of each phase of the work, the CONTRACTOR shall check and adjust each irrigation head to meet the site requirements and the requirements of the Contract Documents.

1.5 INSTRUCTION

A. The CONTRACTOR shall, upon completion of the maintenance period of the irrigation instruct the OWNER and the OWNER'S personnel as to the proper operation and maintenance of the system.

1.6 EXISTING UTILITIES AND CONDITIONS

A. Prior to cutting into the soil, the CONTRACTOR shall locate all cables, conduits, sewers, septic tanks, and other such underground utilities, and shall take proper precautions not to damage or disturb such improvements. If a conflict exists between such obstacles and the proposed work, the CONTRACTOR shall promptly notify the L.A.

B. The CONTRACTOR shall be responsible for coordinating its work with the operation of existing utilities and new utilities on the Project. The CONTRACTOR shall notify the L.A. or its representative when utilities which are in operation require shut-off.

C. Due to the scale of Drawings, it is not possible to indicate all offset, fittings, etc., which may be required. The CONTRACTOR shall carefully investigate the structural and finished conditions affecting all its work, and plan its work accordingly, furnishing such fittings, etc., as may be required to meet such conditions. The Contract Documents are generally diagrammatic and indicative of the work to be installed. The work shall be installed in the most direct and workmanlike manner, so that conflicts between irrigation systems, planting, structures, piping, and etc. will be avoided.

D. The CONTRACTOR shall verify the water pressure available at the site before installation of the system to make sure there is adequate pressure (design pressure 30 to 40 psi) to properly operate irrigation heads and valves, and shall also provide pressure reducing valves if required before commencement of any work. Minor additions and adjustments of heads, piping, and circuits shall be made at no additional cost to OWNER where it is necessary to make the irrigation system operate properly.

1.7 STORAGE OF MATERIALS

A. The CONTRACTOR shall be responsible for storage of materials and for damage to the WORK covered by these Contract Documents before final acceptance of its work. The CONTRACTOR shall securely cover openings into the system, and shall cover all apparatus, equipment, and appliances both before and after being set

in place to prevent obstruction in the pipes and the breakage, misuse, or disfigurement of said apparatus, equipment, or appliances.

1.8 SCHEDULING AND COORDINATION

A. The CONTRACTOR shall be responsible for making arrangements for the coordination of its construction operations with those of all others on the job. The CONTRACTOR shall permit others engaged in work to accomplish their portion of the WORK without undue interference or delay.

B. The CONTRACTOR shall be responsible for the scheduling and coordination of the electrical and water connections and the installation of the piping and equipment in a manner that will affect the earliest completion of the WORK in conformance with the construction progress schedules.

C. If electrical service is not already in place, the Contractor will be required to make all necessary arrangements with the power utility company including, but not limited to, paying fees, making power connections, providing poles, weatherhead and meter, etc., as specified on the plans. All permits, fees, and compliance with electrical company requirements, shall be the Contractor's responsibility.

1.9 GUARANTEE/WARRANTY OF THE IRRIGATION SYSTEM

A. The CONTRACTOR shall guarantee the complete irrigation system to be free from leaks or breakage due to defective material or workmanship for a period of one year from the date of acceptance of the complete work by the OWNER. Damage due to sabotage and/or vandalism is specifically accepted from this guarantee.

B. Other items of the required guarantee shall be as specified in the Division 32 Section "Landscape Planting".

C. The CONTRACTOR shall repair any settling of backfilling trenches occurring during a one year period after final acceptance without expense to the OWNER including complete restoration of all damaged planting, paving, or other improvements of any kind.

D. The CONTRACTOR shall provide winterization of the irrigation system during the one year guarantee period.

E. When defective material or workmanship is discovered which will require repair or replacement, all such repair work or replacement work shall be done by the CONTRACTOR at its own expense within 24 hours after written notification is given to the CONTRACTOR by the OWNER of such required repairs. However, if the CONTRACTOR fails to comply with the requirements of the above guarantee within the 24 hours after notification is given, the OWNER shall proceed to have the repairs made by others at the CONTRACTOR'S expense.

PART 2 - PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall furnish, at no additional charge, all samples necessary for testing as outlined in the Specifications or, when requested, certified evidence of off-site testing

B. The electrical point of connection for the irrigation system automatic controller shall be 120-volt building electrical supply or as per manufacturer's recommendations.

C. The maximum flow for the irrigation system shall not exceed 7ft./second.

2.2 PIPE

A. All piping, (except flex swing pipe) shall be Schedule 40 P.V.C. with ratings printed on pipe. See detailed drawings. No pipe shall be less than 1" inside diameter. Do not use galvanized fittings of any kind on any PVC lines or fittings. New pipe is to be new, free of cracks, holes, foreign material, blisters inside bubbles, wrinkles, and dents.

B. Main Lines are to be sized appropriately to handle the gallons per minute (GPM) required to serve the three largest lateral systems. Main line piping shall be connected by solvent welded, or gasketed joints (see table). Use primer and cement (glue) for the appropriate pipe type, applied per manufacturer's specifications. All connections on Main Lines must be allowed to set for twenty-four hours prior to pressurization. All gasketed pipe fittings must be thrust blocked against undisturbed soil. Refer to detail.

C. Main Lines shall have a thrust block of poured concrete installed at each change of direction. The thrust block shall be of sufficient size for the pipe involved and rest on undisturbed ground. Refer to detail.

D. Lateral Pipe shall be either solvent weld or threaded connections. Solvent welded Lateral Lines shall have the same specifications described for the Main Line Pipe. Threaded connections shall have Teflon Tape and/or Rector Seal, applied per manufacturer's specifications.

E. Flex or Swing Pipe shall be thick-walled polyethylene pipe, kink resistant, rated to at least 80 psi, and with a minimum of a two year warrantee; equal to Rain Bird SPX series swing pipe. This pipe is to be used only between heads and lateral lines and will not exceed lengths of 2 feet. Use only on heads with 3/4" or smaller inlets. For heads with 1" or larger inlets, install a prefabricated swing joint of appropriate size.

F. Pipe and Fittings Table:

A.

Size	Mainline Piping	Mainline Fittings	Lateral Piping	Lateral Fittings
1"	SCH 40	SCH 40	SCH 40	SCH 40
1-1/4"	SCH 40	SCH 40	SCH 40	SCH 40
1-1/2"	SCH 40	SCH 40	SCH 40	SCH 40
2"	SCH 40	SCH 80	SCH 40	SCH 80
2-1/2"	PVC Class 200 Gasketed	Gasketed Fittings	SCH 40	SCH 80
3"	PVC Class 200 Gasketed	Gasketed Fittings	SCH 40	SCH 80
4"	PVC Class 200 Gasketed	Gasketed Fittings		

2.3 Sleeves

A. All sleeves shall be PVC Class 200 PVC and be 2 sizes larger than the total outside diameter of the piping contained in the sleeve. Sleeves shall be a minimum of 4" diameter.

2.4 VALVES

A. Gate valve shall be as indicated on the Drawings.

B. Isolation valves shall be as indicated on the Drawings.

C. Remote Control Valves shall be as indicated on the Drawings.
   1. Remote control valves shall be housed in a poly plastic valve box with locking lid and gravel base.
   2. Remote control valves shall be installed in separate valve boxes - Do not install valve manifolds.

D. Quick-coupling valves shall be as indicated on the Drawings.

E. Master valve and flow sensor shall be as indicated on the Drawings.

F. Except in rare instances, all valve boxes shall be located in shrub/perennial beds as approved by the L.A.

2.5 AUTOMATIC CONTROLLER

A. Automatic controller shall be as indicated on the Drawings.

B. Contractor to provide a circuit map to be laminated and installed in the controller cabinet.

2.6 IRRIGATION HEADS

A. Irrigation heads shall be the model and type indicated on the Drawings.

2.7 WIRING AND ELECTRICAL WORK

A. All electrical equipment and wiring shall comply with local and state codes and shall be installed by those skilled and licensed in the trade. Unless the governing codes specify otherwise, low voltage control wire may be installed by the CONTRACTOR when code allows.

B. All 110-volt wire shall be installed in conduit and taken from appropriate sources as indicated on the Drawings. CONTRACTOR shall coordinate manufacturer and installer

C. The CONTRACTOR shall provide low voltage, 24-volt direct burial wires. Wire size shall be as shown but shall be not less than No. 14. Where sizes are not shown, they shall be sized per wire manufacturer's sizing charts and specifications.

D. The CONTRACTOR shall provide all wiring, conduit, sweeps, fittings, sleeves, and connection for the low voltage electrical system between controller and valves, and where else shown and necessary for a complete and operable irrigation system.

E. All splices shall be moisture proof using specified electrical connectors.

F. All control wires shall be installed in 1" HDPE conduit between valve boxes and controller. Install wire in the bottom of the main line trench maintaining 12" offset from the main line. Include sweep ells at all corners and angles and into valve and junction boxes.

G. An expansion curl should be provided within 3 ft of each wire connection and at pull box locations. Provide three feet of extra wire in each valve box.

H. All conduits and sleeves necessary for running wires under concrete, walks, and paving shall be furnished and installed before said concrete, walks, and paving work is installed.

2.8 Wire shall be continuous without splices except at control valves, and shall be routed in main line trench whenever possible PVC SOLVENT CEMENT AND PRIMERS

A. Solvent Cement shall be NSF approved and shall meet requirements of ASTM D 2564.

B. Primer shall be NSF approved and shall be Weld-On, P-70 Industrial Polychemical Service or approved equal.

2.9 VALVE AND CONTROLLER BOXES

A. Boxes for valves shall be heavy duty, green (grass) tan (mulch), plastic Rain Bird, Carson-Brooks, complete with locking lids, or approved equal.

2.10 MANUAL DRAIN VALVE

A. Manual Drain Valve shall be as indicated on the drawings or approved equal.

2.11 OTHER MATERIALS

A. Other materials required or necessary shall be as shown and/or as required for best quality work.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of the irrigation system shall be performed after the finish grading, but prior to landscaping.

B. All valves, fittings, heads, and piping shall be installed as indicated on the Drawings and all connections made to permit the irrigation system to function properly through its entire length.

C. All materials and equipment shall be installed in strict accordance with manufacturer's written instructions and recommendations and all local and state codes, laws, ordinances, and regulations.

D. Before proceeding with the installation of any section or unit of the irrigation system, the CONTRACTOR shall check and verify the correlation between ground measurements and Drawings and shall advise the L.A. of any discrepancies.

E. The total number of irrigation heads and circuits and size of pipes shall be not less than shown unless otherwise approved. The stated maximum spacing for each type of irrigation head shall not be exceeded.

3.2 EXCAVATION

A. Stake location of piping and irrigation heads for approval prior to trenching.

B. Barricade and secure open trenches to effectively prevent accidental entry.

C. Trenches shall be dug as wide and as deep as necessary to properly install the irrigation pipe.

D. Pipe trenches shall be straight, or "snaked" slightly allowing for expansion and contraction of PVC pipe.

E. Subsoil shall be kept separate from topsoil, where possible.

F. Minimum cover depth shall be as follows:
   1. Supply pressure lines from water source to control valves: 30 inches minimum unless otherwise indicated on the Drawings.
   2. Lateral lines from control valves to irrigation heads; 18 inches minimum unless otherwise indicated on the Drawings. Lateral lines under paving, roadways, and driveways shall have 18 inches of cover and located in sleeves.
   3. Trenches for control wire only shall be 18 to 30 inches deep unless otherwise indicated on the Drawings. Control wires under concrete walks and slabs, paving, roadways, and driveways shall be installed in Schedule 40 PVC sleeves.

G. A trench of sufficient width shall be provided to allow for proper tamping around pipe.

H. Locate trenches a minimum of 6" away from adjacent hardscape elements.

3.3 PIPING-GENERAL

A. Piping shall be laid out and installed in accordance with manufacturer's printed recommendations and industry standards. Substantial support shall be provided at all points, and pipes shall be snaked slightly allowing for expansion and contraction.

B. Minimum 1-inch vertical clearance shall be between lines crossing at angles greater than 45 degrees.

C. Minimum 3 inches horizontal and vertical clearances shall be between all other lines.

D. All swing or swivel joints shall provide a leak-resistant joint with freedom of movement.

E. Teflon thread sealant 3/4-inch wide (tape or liquid), or approved equal shall be used at all threaded joints.

F. Galvanized steel pipes shall have clean standard threads of standard lengths. Joints shall be made up with pipe compound applied to male threads only and not more than 2 threads shall show at the joints when connected.

G. Pipe sleeves shall be provided under all paving and where necessary for passage under finish surface material, future replacement, and for protection of PVC piping and control wire.

3.4 PLASTIC PIPE

A. The pipe shall be guaranteed by the manufacturer to be suitable for operation under the conditions of this installation and shall be guaranteed free from defects in workmanship and quality.

B. The pipe shall be connected by O-ring type or by solvent-weld joints as outlined below. Joints shall be made in strict accordance with the manufacturer's printed recommendation.

C. The plastic pipe sections shall be placed accurately to line and grade in the prepared trenches. The inside of all pipe shall be clean and free from foreign matter and shall be end-reamed to remove burrs and provide full inside diameter of the nine end.

D. Pipe assembly shall have a firm, uniform bearing for the entire length of each pipeline to prevent uneven settlement. All adjustments to grade shall be made by scraping away or filling in with clean earth backfill material, well compacted under the body of the pipe. Wedging of pipe will not be permitted. The inside of all pipes shall be clean and free from foreign materials before joints are assembled.

E. Sealant tape shall be used on all threaded joints.

F. All pipeline open ends upon which the WORK has been stopped shall be closed at the end of each day's construction work with a suitable temporary plug to prevent entrance of any foreign materials into the assembled pipeline.

G. Pressure pipe shall be defined as all piping lying "upstream" from remote control valves and quick-coupling lines.

H. O-Ring type flexible coupling pipe shall be used on pressure pipes 4-inch diameter and larger.

I. Three inch and smaller mainlines and fittings of pressure piping shall be solvent-weld type.

J. Pressure piping 3-inch and larger shall be provided with Portland cement concrete thrust blocks. Thrust blocks shall be constructed at the following places:
   1. Where pipe changes direction at fittings.
   2. Where pipe changes size.
   3. Where line terminates.

K. Thrust blocks shall be constructed of 2000 psi concrete, as noted on Drawings and details.

L. The areas noted on the details table shall be measured in a place perpendicular to the longitudinal axis of the pipe or to the longitudinal axis of the thrust developed. The thrust block bearing area shall be against undisturbed around.

M. Compression fitting (compression by compression slip joint PVC) shall be provided on mainline at 250 on center for expansion and contraction of mainline on straight runs on solvent welded pipe.

3.5 VALVES

A. Piping systems shall be supplied with valves at all points as indicated on the Drawings or specified herein so arranged to give complete regulating control throughout. Automatic control valves and gate valves shall be as detailed in the Contract Documents or as otherwise directed by the L.A..

B. Valves shall be the full size of the line in which they are installed, unless otherwise indicated on the Drawings.

C. Remote control valves shall be adjusted so the most remote irrigation heads operate at the pressure recommended by the head manufacturer. Remote control valves shall be adjusted so a uniform distribution of water is applied by the irrigation heads to the planting areas for each individual valve system. A union fitting shall be provided on both sides of the control valve. They shall be wired to operate in the order as shown. They shall be capable of being operated manually entirely independent of the controller.

D. Isolation shall be installed as indicated on the Drawings.

E. Gate valves shall be line (pipeline) size, shall be installed where indicated on the Drawings.

F. Quick-coupling valves shall be provided, located, and installed as indicated on the Drawings.

3.6 VALVE BOXES

A. All valve assemblies shall be installed as indicated on the Drawings.

B. Except in rare instances, all valve boxes shall be located in shrub/perennial beds as approved by the L.A.

C. Place valve boxes parallel or perpendicular to adjacent curbs or paving.

3.7 CHECK VALVES

A. Check Valves shall be installed as indicated on drawings and where necessary to prevent water flow from lower-elevation heads when system is turned off. Install per manufacturers recommendations with a one cubic foot (min.) gravel sump around each drain.

3.8 MANUAL DRAIN VALVE

A. Manual Drain Valve shall be installed along main line at all low spots to ensure completed drainage and winterization of main line. All manual drains shall be placed in separate valve boxes per installation details.

3.9 IRRIGATION HEADS

A. All nozzles on irrigations shall be tightened after installation. All irrigations having an adjustment stem shall be adjusted on a lateral line for the proper radius diameter and/or flow

B. All irrigation heads shall be set perpendicular to finished grades and at finish ground level.

C. All irrigation heads shall be installed as detailed on the Drawings.

D. The irrigation system shall be thoroughly flushed remove all possible foreign material prior to installation of the irrigation heads.

E. The CONTRACTOR shall protect against re-entry of contaminated water into risers or piping. After flushing, the CONTRACTOR shall immediately install irrigation heads or cap risers until irrigation heads are installed.

3.10 CONTROLLER

A. Connect proposed remote control valves to controller as indicated on drawings.

3.11 WIRING AND ELECTRICAL WORK

A. All electrical equipment and wiring shall comply with local and state codes and shall be installed by those skilled and licensed in the trade. Unless the governing codes specify otherwise, low voltage control wire may be installed by the CONTRACTOR when code allows.

B. All 110-volt wire shall be installed in conduit and taken from appropriate sources as indicated on the Drawings. CONTRACTOR shall coordinate manufacturer and installer

C. The CONTRACTOR shall provide low voltage, 24-volt direct burial wires. Wire size shall be as shown but shall be not less than No. 14. Where sizes are not shown, they shall be sized per wire manufacturer's sizing charts and specifications.

D. The CONTRACTOR shall provide all wiring, conduits, sleeves, and connection for the low voltage electrical system between controller and valves, and where else shown and necessary for a complete and operable irrigation system.

E. All splices shall be moisture proof using specified electrical connectors and be contained in valve box.

F. Install wire in the bottom of the main line trench maintaining 12" offset from the main line. Include sweep ells at all corners and angles. Bundle and tape control wires every 10ft.

G. An expansion curl should be provided within 3 ft of each wire connection and at pull box locations. Provide three feet of extra wire in each valve box.

H. All conduits and sleeves necessary for running wires under concrete, walks, and paving shall be furnished and installed before said concrete, walks, and paving work is installed.

I. Wire shall be continuous without splices except at control valves, and shall be routed in main line trench whenever possible.

3.12 PIPE TRENCH BACKFILL

A. After pipe and wires have been installed, the trenches shall be backfilled. The backfill operation must provide a firm continuous support for the pipe.

B. Backfill material shall be free of rocks and other materials that may damage the piping.

C. Bottom of trenches shall be smooth and free of sharp rocks and other object that may damage pipe.

D. The initial backfill shall be accomplished by carefully tamping selected material (from material excavated from the trench) under the pipe and between the pipe and the trench.

E. The pipes shall be filled with water and pressurized during backfilling operations if necessary, to prevent drainage to piping.

F. The backfill shall be carefully installed around and over the pipe to approximately 10 inches of the ground surface, then water shall be allowed to flow in the trench. After this puddling operation has been completed and allowed to stand for 24 hours, the balance of the materials shall be placed in the trench to the sub-grade line (leaving room for topsoil) Rocks and other materials found in the backfill shall be removed. The backfill shall be compacted carefully and thoroughly.

G. Couplings and fittings shall be left exposed until leakage tests have been completed.

H. Topsoil shall be installed prior to planting.

I. Install detectable warning tape as indicated on the Drawings.

3.13 TESTING AND ADJUSTMENTS

A. The L.A. shall be notified by the CONTRACTOR prior to performing hydrostatic tests on the irrigation system in place. This test shall be done by the CONTRACTOR in the presence of the L.A.. The test results will be acceptable to the L.A. when no leakage or loss of pressure is evident during the test period. Defects shall be detected and repaired prior to retesting.

B. The irrigation heads shall be adjusted and balanced for optimum and uniform coverage without excessive fogging and overthrow on walks, paving, and structures. The height and elevations of risers and irrigation heads shall be adjusted.

C. Following adjusting and balancing of the irrigation heads, an operating test of the entire system shall be performed by the CONTRACTOR in the presence of the L.A. at normal operating pressures. The test will be considered as acceptable if the system operates in a satisfactory manner providing uniform coverage of irrigated areas for a one week period of automatic operation with no leaks.

3.14 WATER AUDIT

A. Prior to issuing substantial completion letter, the contractor shall have a water audit conducted by a Certified Landscape Irrigation Auditor to determine irrigation system efficiency.

B. Results of Water Audit must indicate a minimum of 70% distribution of uniformity.

1. If results of water audit fail to meet requirement listed above. The contractor shall be responsible for making adjustments to the system as necessary to meet the minimum requirements.
2. Cost for conducting water audit and any adjustments to the system necessary to meet the 70% requirement shall be borne by the contractor.

A.

3.15 ACCEPTANCE AND OPERATION BY OWNER

A. Upon substantial completion of the work and acceptance by the Owner, the Engineer will issue a date of substantial completion letter to the contractor. Contractor shall be responsible for the training of the owner's maintenance staff in the operation of the system (provide minimum 48 hours written notice in advance of test). The Contractor shall furnish, in addition to the Record Drawings and operational manuals, copies of all available specification sheets and catalog sheets to the Owner's personnel responsible for the operation of the irrigation system. The Contractor shall guarantee all parts and labor for a minimum period of one (1) year from date of substantial completion.

B. Contractor to obtain a Substantial Completion Form and Irrigation Schedule Form from the Owner and fill out forms complete and return to Owner.

3.16 RECORD DRAWINGS

A. Record Drawings shall be furnished to the L.A. at the time of the irrigation system inspection and before acceptance of the operating system by the OWNER. See section 1.3 "Contractor Submittals".

B.

END OF SECTION

SECTION 32 9300 – LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall perform all the landscaping and all appurtenant work, complete, in accordance with the requirements of the Contract Documents.

B. Scope of Work: Landscaping as referred to herein shall include, but not be limited to the following work: soil preparation, weed control, finish grading, furnishing and installing plant materials, tree staking and tying, cleanup, maintenance, and guarantee.

C. The Section cross references the following sections:
1. Division 01 Section "Reference Standards"
2. Division 01 Section "Contractor Submittals"
3. Division 01 Section "Project Closeout"
4. Division 03 Section "Concrete"
5. Division 32 Section "Landscape Irrigation"

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications:
1. FS O-F-241 D Fertilizer, Mixed, Commercial

B. Commercial Standards:
1. ANSI/ASTM D 422 Method for Particle-Size Analysis of Soils
2. ANSI Z601 Nursery Stock
3. American Association of Rules and Grading Provisions Nurserymen, Inc.

1.3 CONTRACTOR SUBMITTALS

A. General: The CONTRACTOR shall furnish a certificate with each delivery or bulk material delivery, stating source, quantity, and type of material. All materials shall conform to specification requirements. All certificates shall be delivered to the LANDSCAPE ARCHITECT (here in referred to as L.A.) at time of each delivery. All bulk delivered materials shall be delivered with level load volume plainly marked on the truck bed.

B. Submittals required shall be submitted as specified in Division 01 Section "Contractor Submittals":
1. Topsoil Report
2. Literature on Fertilizers and additives
3. Mulches
4. Weed barrier fabric
5. Literature on staking materials
6. Landscape Boulder

1.4 QUALITY ASSURANCE

A. General: All plants furnished by the CONTRACTOR shall be true to type or name as shown in the Contract Documents and shall be tagged in accordance with the standard practice recommended by the Agricultural Code of the State of Utah; however, determination of plant species or variety will be made by the L.A..

B. All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Inspection certificates required by law shall accompany each shipment of plants, and certificates shall be delivered to the L.A..

C. All inspections herein specified will be made by the L.A. or its representative. The CONTRACTOR shall request inspection at least 24 hours in advance of the time inspection is required. Inspection will be required on the following stages of the WORK:
   1. During preliminary grading, soil preparation, and initial weeding.
   2. When trees are spotted for planting, but before planting holes have been excavated.
   3. When finish grading has been completed.
   4. When all specified work, except the maintenance period has been completed.
   5. Final inspection at the completion of the maintenance period.

D. Plants shall be subject to inspection and approval or rejection by the L.A. at place of growth and upon delivery to the site at any time before or during progress of the WORK and according to:
   1. Quantity, quality, size, and variety.
   2. Ball and root condition; and
   3. Latent defects and injuries resulting from handling, disease, and insects.

E. Plants approved at pre-planting inspection shall still be subject to rejection during planting if found to be below Specifications.

F. Rejected plants shall be identified in an obvious manner, promptly removed from the site and replaced with acceptable equals.

G. Plants shall have been grown in nurseries which have been inspected by the governing authorities. Inspection of plant materials required by City, County, State, or Federal authorities shall be the responsibility of the CONTRACTOR, who shall have secured permits or certificates prior to delivery of plants to site.

1.5 CLEANUP

A. Upon completion of all planting operations, the portion of the project site used for a work or storage area by the CONTRACTOR shall be cleaned of all debris, superfluous materials, and equipment. All such materials and equipment shall be entirely removed from the project site as specified in Division 01 Section "Project Closeout".

B. All walks or pavement shall be swept or washed clean upon completion of the work of this Section.

C. During the entire Contract period, plant containers that have been cut or removed from plant materials shall be removed from the project site daily, in accordance with the provisions for maintenance and guarantee as specified in Division 01 Section "Project Closeout".

1.6 MAINTENANCE OF LANDSCAPE PLANTING PRIOR TO ACCEPTANCE OF PROJECT

A. General: The CONTRACTOR shall be responsible for protecting, watering, and maintaining all planting and irrigation systems until final acceptance of all work under the contract.

B. At time of acceptance of the complete project, the lawn shall be totally established with no bare spots, mowed a minimum of 2 times, and the grass shall be at least 1-1/4 to 2 inches in height.

C. Watering: Trees and shrubs shall be thoroughly soaked after planting and provided with additional water at intervals as necessary to provide for good health and growth of the planting.

D. Upon completion of lawn sodding, the entire area shall be soaked to saturation by a fine spray. The new planting shall be kept watered by the irrigation system existing on the site during dry weather or whenever necessary for proper establishment of the lawn. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired by the CONTRACTOR at its own expense.

E. Protection: The CONTRACTOR shall provide adequate protection to all newly planted areas including the installation of approved temporary fences to prevent trespassing and damage, as well as erosion control, until acceptance.

F. The CONTRACTOR shall replace any materials or equipment it has damaged or which has been damaged by its employees or subcontractors.

G. Partial utilization of the project shall not relieve the CONTRACTOR of any of the requirements contained in the Contract Documents.

H. Mowing of Lawn Areas: First mowing of lawn areas shall begin as soon as the grass has reached a height of 3 inches and subsequent mowing shall be at least once a week, or as often as necessary to maintain all lawn areas at a uniform height of 1-1/2 to 2 inches.

I. All lawns shall be fertilized every 3 weeks with 6 lb of 16-8-8 commercial fertilizer per 1000 sq ft for the first 7 weeks and fertilized thereafter once each 5 months prior to acceptance.

J. Plants shall be maintained in a vigorous, thriving condition by watering, cultivating, weeding, pruning, spraying, and other operations necessary. No trees or shrubs will be accepted unless they are healthy and show satisfactory foliage conditions.

K. All planted areas shall be cultivated at least every 2 weeks and raked smooth, to present a neat appearance and additional mulch shall be added where necessary.

L. Maintenance shall include, in addition to the foregoing, cleaning, edging, repairs to stakes, wire, and wrappings, the repair of erosion, and all other necessary work of maintenance. Sidewalks and other paved areas shall be kept clean while planting and maintenance are in progress.

M. Any and all irrigation lines broken or disrupted during this construction shall be replaced to proper working order prior to contract work and be acceptable to the OWNER.

1.7 FINAL INSPECTION AND GUARANTEE

A. Inspection of work of lawns and planting will be made at conclusion of maintenance.

B. Written notice requesting inspection shall be submitted to the L.A. at least 10 days prior to the anticipated inspection date.

C. Final acceptance of the WORK prior to guarantee period of the contract will be accepted upon written approval by the L.A., on the satisfactory completion of all work, including maintenance, but exclusive of the replacement of plant material.

D. Any delay in the completion of any item of work in the planting operation which extends the planting into more than one season shall extend the guarantee in accordance with the date of completion given above.

E. The CONTRACTOR shall replace, as soon as weather conditions permit, all dead plants and all plants not in a vigorous, thriving condition which are noted at the end of the one year guarantee period.

F. Plants used for replacement shall be of the same size and variety specified in the plant list. Plants shall be furnished, planted, staked, and mulched as specified.

G. All work done under this contract shall be left in good order to the satisfaction of the OWNER and the L.A. and the CONTRACTOR shall, without additional expense to the OWNER, replace any trees, shrubs, etc., which develop defects or die during the one-year guarantee period.

1.8 GUARANTEE FOLLOWING ACCEPTANCE OF PROJECT

A. General: The CONTRACTOR shall be responsible for a period of one year after date of acceptance of all work under the Contract, for all necessary plant or tree replacements. The CONTRACTOR shall provide a written guarantee to the OWNER from the landscaping subcontractor, embodying the provisions of this Section of the Specifications.

B. The WORK covered by the guarantee portions of these specifications consists of providing all replacements of plants, labor, materials, equipment, and supplies and in performing all operations in connection with guarantees.

C. The CONTRACTOR shall clean-up and remove unused or waste materials from the site and leave the area in a neat condition (satisfactory to the OWNER) whenever it performs work during the guarantee Period.

D. Final Inspection: The OWNER and CONTRACTOR shall make a final inspection at the end of the one-year guarantee period. Any plants and materials found defective at time of final inspection shall be replaced within a time agreed upon by both parties. If it is too late in the planting season for replanting, the replacements shall be made during the next planting season even though such planting may run beyond the maintenance and correction period.

PART 2 - PRODUCTS

2.1 GENERAL

A. All landscaping materials for soil conditioning, weed abatement, or planting shall be first- grade, commercial quality and shall have certificates indicating the source of material, analysis, quantity, or weight attached to each sack or container or provided with each delivery. Delivery certificates shall be given to the L.A. as each shipment of material is delivered. A list of the materials used, together with typical certificates of each material, shall be submitted to the L.A. prior to the final acceptance of the job.

2.2 TERMINOLOGY AND QUALIFICATIONS

A. Plants or plant material having characteristics not conforming to terms as defined will not be accepted. The terms "plant material" or "plants" refer to all vegetation, whether trees, shrubs, ground cover, or herbaceous vegetation.

B. Quality refers to structure and form, as evidenced by density and number of canes and branches, compactness, symmetry, and general development without consideration of size or condition. Standard quality indicates the least acceptable quality. Plants shall be typical of the species and variety of good average uniform growth, shall be well formed and uniformly branched, and shall have the minimum number of canes specified, free from irregularities, or shall conform to minimum quality index. Where the number of canes is not specifically stated in describing this grade, the standards of the "Horticultural Standards" as

adopted by the American Association of Nurserymen, shall apply. In this case, the number of canes and other factors for the appropriate classification under "quality definition" in the Horticultural Standards shall be the Quality index. Plant material below this standard will be considered "culls" and are not acceptable. Plants shall be nursery grown.

C. Specimen means an exceptionally heavy, symmetrical, tightly-knit plant, so trained or favored in its development and appearance as to be outstanding, superior in form, number of branches, compactness, and symmetry.

D. Size is the factor controlled by dimensions representing height or spread, or both, without consideration of quality or conditions. For standard quality, a dimension is given for height or container size, or a dimension is given for height as well as container size.

E. Height is usually indicated with a tolerance. The smaller dimension is the minimum acceptable. The larger dimension represents the maximum permissible. The average dimension of all plants must equal the average of the tolerance figures shown on each item

F. Condition is the factor controlled by vitality and ability to survive and thrive and be comparable with normal plants of the same species and variety in the vicinity, at the same season of the year. In addition, plants shall be free from physical damage or adverse conditions that would prevent thriving. Conditions also sometimes refer to state of growth, i.e., whether "dormant condition" or "growing condition" and this state shall be comparable to plants of similar species in the vicinity or leaves, formation of buds, and the like.

G. Cane means a primary stem which starts from the ground, or close to the ground, at a point not higher than 1/4 the height of the plant.

H. Caliber shall be taken 12 inches above the finish grade or ground, as a guide, or where a dimension in trunk appears to form the head of the tree.

I. Foliage line is maximum dimension in case of specimen plants. It measures from ground to lowest part of body of plant.

J. Collected plants shall not be used.

2.3 TOPSOIL

A. Imported topsoil borrow shall be obtained from naturally drained areas and shall be fertile, friable loam suitable for plant growth. Topsoil borrow shall be subject to inspection and approval at the source of supply and upon delivery.

B. The topsoil borrow shall be of uniform quality, free from subsoil stiff or lumpy clay, hard clods, hardpan, rocks, disintegrated debris, plants, roots, seeds, and any other materials that would be toxic or harmful to plant growth. Topsoil borrow shall contain no noxious weeds or noxious weed seeds.

C. Topsoil borrow shall meet all specifications below for either "Ideal" or "Acceptable" categories. Soil that falls within the "Not-Acceptable" range shall not be used.

TOPSOIL QUALITY*

Category	pH	Soluble Salts dS/m or mmho/cm	Sodium Absorption Ratio (SAR)	Organic Matter %	Sand %	Silt %	Clay %	Texture Class
Ideal	5.5-7.5	<2	<3	≥2.0	<70	<70	<30	Loam (L), Silt Loam (SiL)
Acceptable	5.0-8.2	<4	3 to 7 SiL, SiCL, CL 3 to 10 SCL, SL, L	≥1.0	<70	<70	<30	Sandy Clay Loam (SCL) Sandy Loam (SL) Clay Loam (CL) Silty Clay Loam (SiCL)
Not-Acceptable	<5.0 >8.2	>4	>10	<1.0	≥70	≥70	≥30	Loamy Sand (LS) Sandy Clay (SC) Silty Clay (SiC) Sand (S), Silt (S), Clay (C)

COARSE FRAGMENTS*

Category	%>2 mm (>5.0% exceeds guidelines)	Rocks Present >1.5" (>1.5" exceeds guidelines)

Ideal	□2.0	—
Acceptable	2.1-5.0	—
Not-Acceptable	>5.0	—

TOPSOIL NUTRIENT SPECIFICATION*

	Nitrate Nitrogen ppm	Phosphorus ppm	Potassium ppm	Iron ppm
Ideal / Acceptable	>20	>15	>150	>10

*from "Topsoil Quality Guidelines for Landscaping", June 2002, AG/SO-02, prepared by Rich Koenig, Utah State University Cooperative Extension Soil Specialist, and Von Isaman, QA Consulting and Testing, LLC.

D. Mechanical Analysis shall be performed and shall conform to ANSI/ASTM D 422.

2.4 COMPOST

A. Topsoil shall meet requirements listed above and be amended with 3 cubic yards of compost/1000 sq. ft. for every 3-inches of soil depth. Compost shall be incorporated into topsoil by rototilling. Compost shall meet all specifications below for either "Ideal" or "Acceptable" categories. Compost that falls within the "Not-Acceptable" range shall not be used.

COMPOST QUALITY GUIDELINES FOR LANDSCAPING*

	pH	Soluble Salts dS/m	Sodium Absorption Ratio (SAR)	Carbon:Nitrogen Ratio (C:N)%	Moisture%	≥ 98% Coarse Material Passing (dry
Ideal	6 to 8	≤5	<10	≤20:1	25 to 35	3/8"
Acceptable	5-6, 8-9	≤10	≤20	21:1 to 30:1	<25, >35	3/4"
Not-Acceptable	<5.0, >9.0	>10	>20	<10:1, >30:1	<20, >50	<98% 3/4"

*Von Isaman MS, Pres. Of QA Consulting and Testing, LLC., Dr. Rich Koenig, Utah State University Cooperative Extension Soils Specialist, and Dr. Teresa Cerny, USU Cooperative Extension Horticulturalist, 3 March 2003.

2.5 FERTILIZER AND ADDITIVES

A. Fertilizer and additives shall be determined by the Topsoil Analysis and based on section 2.3.

B. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon.

C. Chemical fertilizers shall be a mixed commercial fertilizer conforming to FS O-F-241 D, Type I, with percentages of nitrogen, phosphoric acid, and potash at 5-10-5 and 16-16-8. The combined N-P-K content shall be following percentages of total weight: 5 percent nitrogen 10 percent phosphoric acid and 5 percent potash. Fertilizers shall be uniform in composition, dry, and free flowing.

D. Tablets shall be 21 grams each 20-10-5 Agriform, Lesslie, or approved equal.

2.6 MULCH

A. Rock Mulch:

1 ½"-3" and 3"-6" fractured rock and , tan/beige in color, as approved by Landscape Architect. Available from the following suppliers:

-Mt. Nebo Sand & Gravel 435.623.5138

-Staker & Parson Companies 435.409.9500

-Geneva Rock Sand & Gravel 801.479.6550

-Or approved equal.

B. Landscape Boulder
INKOM BOULDER
1. Distributor: Waters Edge
2. Model: Inkom, Idaho Basalt Boulder (or approved equal)
3. Sizes: See plan and details
4. Contact: Jon Weiberg, 801.856.1777

C. Wasatch Chat Mulch:

3/8" minus and, grey in color, as approved by Landscape Architect. Available from the following suppliers:

-Staker & Parson Companies 801.731.1111

-Or approved equal.

2.7 PLANT MATERIALS

A. Plants shall meet requirements of the Contract Documents and shall be in accordance with the botanical names and applicable standards of quality, size, condition, and type. They shall be true to name, genera, species, and variety in accordance with reference publications.

B. Plant names are defined in "Standardized Plant Names" and "Bailey's Encyclopedia of Horticulture." When a name is not found in either reference, the accepted name used in the nursery trade shall apply.

C. Plants shall be marked for identification. Each bundle of plants and at least 25 percent of each species and variety of separate plants in any one shipment shall have legible labels securely attached before delivery to the site.

D. All trees and shrubs shall be measured while their branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch or root tip to tip. No trees will be accepted with their leaders cut, or so damaged that cutting is necessary.

E. All plants shall be symmetrical and shall conform to the size, age, and condition as specified on the plant list shown in the Contract Documents. Exceptions are as follows:
1. Plants larger than specified in the plant list may be used if approved by the L.A., but use of such plants shall not increase the contract price. If the use of larger plants is approved, the spread of roots or ball earth shall be increased in proportion to the size of the plant. Bare root plants furnished in size greater than specified shall be balled and burlaped when required by the L.A.
2. Where caliper or other dimensions of any plant materials are omitted from the Plant List, it shall be understood that such plant materials shall be normal stock for type

F. Plants shall be of sound health, vigorous, and free from plant disease and shall be well-branched, shall have full foliage when in leaf, and shall have a healthy well-developed normal root system. Cold storage plants will not be accepted. Plants that are sensitive to shock from elevation change shall be grown at elevations close enough to site to alleviate any plant damage due to such change for at least 2 years.

G. Bare rooted (BR) plants shall have well-developed branch systems and vigorous root systems. They shall be dug to sufficient depth to insure full recovery and development of the plants. Roots of these plants shall be covered with a uniformly thick coating of mud being puddled immediately after they are dug

H. Balled and burlaped (BB) plants shall have firm, natural balls of earth, or diameter not less than that specified and of sufficient depth to include all the fibrous and feeding roots. No plant moved with a ball will be accepted if the ball is cracked or broken before or during plant operations, except on special approval of the L.A.

I. Roots or balls of all plants shall be adequately protected at all times from sun and drying winds.

J. Plants (indicated to be in marked cans, pots, or other containers on the plant list) shall have been grown in the containers for a minimum of 6 months and a maximum of 2 years. Roots shall fill the containers but show no evidence of being or having been root bound.

K. Trees shall have straight trunks and all old abrasions and cuts shall be completely callused over. In no case shall trees be topped before delivery.

L. Plants shall have been transplanted or root-pruned at least once in the 2 years. Plants shall not be pruned prior to delivery except as authorized by the L.A..

2.8 SOD GRASS

A. The sod shall be nursery grown and as indicated on Drawings. It shall be uniformly cut approximately 3/4-inch or more thick and shall be well rooted, 2-year old growth of permanent and desirable grasses indigenous to this general location. The sod shall be practically free from weeds and undesirable grasses.

2.9 STAKING MATERIALS

A. Staking System: As indicated on Drawings

B. Guying System: As indicated on Drawings.

C. Flags: Standard surveyor's plastic flagging tape, white, 8 inches long.

2.10 WEED BARRIER FABRIC

A. Weed barrier fabric shall be one of the following:
1. "Dewitt@ Weed Barrier Pro 5, ATypar@ #3301, "Polyspun" XL,
2. or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. The landscape work shall not be performed at any time when it may be subject to damage by climatic conditions.

B. The CONTRACTOR shall verify all dimensions in the Contract Documents. Dimensions and plant locations shown shall be coordinated with L.A. and final location shall be site-oriented by the planter and L.A.. Any discrepancies or inconsistencies discovered shall be brought to the attention of the L.A..

C. In case of conflict between the plant list totals and total plant count of the Contract Documents, the CONTRACTOR shall provide the higher number of plants.

D. Delivery of materials may begin only after samples and tests have been approved by the L.A. All materials furnished for the work shall be not less than the approved sample.

E. Substitutions for the indicated plant materials may be permitted pursuant to the Contract Documents.

F. The CONTRACTOR shall provide temporary fencing, barricades, covering, or other protections to preserve existing landscaping items indicated to remain and to protect the adjacent properties and other structures when they may be damaged by the landscape work. As indicated on Drawings.

G. Waste materials shall be removed and disposed of off the OWNER's property, unless otherwise indicated.

H. It shall be the responsibility of the CONTRACTOR to avail itself of any information regarding utilities which are in the area of work and to prevent damage to the same. The CONTRACTOR shall provide protection to the utilities as necessary.

I. Burning of combustible materials on the site shall not be permitted.

J. The CONTRACTOR shall provide protection to structures, sidewalks, pavements, and other facilities in areas of work which are subject to damage during landscape work. Open excavations shall be provide with barricades and warning lights which conform to the requirements of governing authorities and the State's OSHA safety requirements from dusk to dawn each day and when needed for safety.

K. Planting areas include all areas to be landscaped unless, specified or shown, otherwise.

3.2 SOIL PREPARATION

A. PRIOR to placement of topsoil and amending of topsoil, a Topsoil Report shall be preformed for the existing site topsoil conditions and if used the imported topsoil. The existing and proposed topsoil shall be amended to meet the above specifications in Section 2.3 Topsoil.

B. The landscape work shall not begin until all other trades have repaired all areas of settlement, erosion, rutting, etc., and the soils have been re-established, re-compacted, and refinished to finish grades. The L.A. shall be notified of all areas which prevent the landscape work from being executed.

C. Areas requiring grading by the landscaper including adjacent transition areas shall be uniformly level or sloping between finish elevations to within 0.10-ft above or below required finish elevations.

D. The landscape work shall not proceed until after walks, curbs, pavings, edging, and irrigation systems are in place. The contract operations shall be completed to a point where the landscape areas will not be disturbed. The subgrade shall be cleaned free of waste materials of all kinds.

E. During grading waste materials in the planting areas such as weeds, rocks (1 inches and larger) building materials, rubble, wires, cans, glass, lumber, sticks, etc., shall be removed from the site. Weeds shall be dug out by the roots.

F. Fertilizers, additives, peat, etc. subject to moisture damage shall be kept in a weatherproof storage place in such a manner that they will be kept dry.

G. After removal of waste materials the planting areas subgrade shall be scarified and pulverized to a depth of not less than 6 inches and all surface irregularities below the cover of soil removed.

H. Finish subgrade and amended topsoil placement and grading shall consist of:
1. Prepare subgrade by rough grading and removing all irregularities and debris, then till and scarify subsoil to a depth of 6 inches before placing topsoil. Dig subgrade down as required in shrub beds, turf areas for the placement of amended topsoil. Provide laser leveling on large flat areas to create a uniform level subgrade.
2. Landscape contractor is responsible for the last 7 inches of grade in turf sod areas (6 inches of topsoil and 1 inch for sod) and 16 inches in shrub bed areas (3 inches of bark mulch and 12" of amended topsoil). Refer to grading plan for finish grade and drainage. Subgrade soil shall be in a loosened and rough surface finish before amended topsoil is placed over subgrade. (Sub-grade surface shall not be smooth, but a rough surface shall exist for a transition zone of amended topsoil to subsoil.) If areas of subgrade become compacted before amended topsoil is placed, subgrade shall be tilled again before amended topsoil placement.

3. Placing all amendments, soil additives and fertilizers for the areas as noted on the plan and per the topsoil report.
4. Till lawn and planting area subsoil's and topsoils that are compacted.
5. After tilling, bring areas to uniform grades by floating and/or hand raking. In large open level areas, perform laser leveling to create uniform level areas.
6. Make minor adjustment of finish grades as directed by the landscape architect or owner.
7. Remove waste materials over 1" in size such as stones, roots, or other undesirable foreign materials and finish raking, dishing, dragging, and smoothing soil ready for planting.
8. No grading or soil placement shall be undertaken when soils are wet or frozen

I. Any unusual subsoil condition that will require special treatment shall be reported to the L.A.

J. Amended topsoil shall be uniformly distributed over all areas where required. Subgrade and amended topsoil shall be damp and free from frost.

K. Surface drainage shall be provided as shown by molding the surfaces to facilitate the natural run-off of water. Low spots and pockets shall be filled with amended topsoil and graded to drain properly.

L. Finish grade for sodded areas shall be 2 inches below finish grade of adjacent pavement. Finish grade (top of bark mulch) shrub bed areas shall be 1 inches below finish grades of adjacent pavement.

3.3 DELIVERY, STORAGE, AND HANDLING OF PLANT MATERIALS

A. No plants other than the required samples shall be dug or delivered to the site until the required inspections have been made and the plant samples are approved

B. Plants shall not be pruned prior to delivery except upon approval by the L.A..

C. Plant material shall be planted on the day of delivery if possible. The CONTRACTOR shall protect the stock in a temporary nursery at the project site where it shall be protected from sun and drying winds and shall be shaded, kept moist, and protected with damp soil, moss, or other acceptable material. Plants shall be planted within 2 days after delivery.

D. All balled and burlapped plants which cannot be planted immediately in delivery shall be set on the ground and shall be well protected with soil, wet moss, or other acceptable material. Bare rooted plants, which cannot be planted immediately, shall be planted on heeled-in trenches immediately upon delivery. No material heeled-in more than one week may be used. Bundles of plants shall be opened and the plants separated before the roots are covered. Care shall be taken to prevent air pockets among the roots.

E. During planting operations, bare roots shall be covered with canvas, wet straw, or other suitable materials. No plants shall be bound with wire or rope at any time so as to damage the bark or break branches.

F. Plants shall not be picked up or moved by stem or branches, but shall be lifted the ball or container.

G. Plants shall be lifted and handled from the bottom of the ball or container. Plants with balls cracked or broken before or during planting operations will not be accepted and shall be immediately removed from the site.

3.4 TREE AND PLANT LOCATIONS

A. The CONTRACTOR shall locate and stake all tree and shrub locations and have the locations approved by the L.A. before starting excavation for same. The plant locations shall be observed, and their locations shall be adjusted as directed by L.A. before final approval.

B. No trees shall be located closer than 72 inches to structures unless otherwise shown. Ground covers and shrubs may be planted up to structures or curbs.

3.5 PLANT PITS

A. Plant pits, centered on location stakes, shall be excavated circular pits with vertical sides and flat or saucer shape bottom in accordance with the following sizes unless shown
   1. Tree pits shall be at least 3 times greater in diameter than the specific diameter of ball or spread of roots, and at depth of ball or roots.
   2. Tree pits shall include drainage sump as indicated on the drawings.
   3. Shrubs shall be planted in pits or holes of soil the depth of ball below finished grade, or as much deeper as necessary to properly set the plant at finished grade.

3.6 PREPARED BACKFILL

A. Tree and shrub pit backfilling soil shall consist of amended topsoil.

B. Tree and shrub pits shall be provided with fertilizer tablets as follows:
   1. 1 per one-gallon can plant
   2. 3 per 5-gallon can plant
   3. 4 per trees

3.7 ROCKS OR UNDERGROUND OBSTRUCTIONS

A. In the event that rock or underground obstructions are encountered in the excavation of plant pits, alternative locations shall be selected by the L.A.. Moving of trees to alternative locations shall not entail additional costs to the OWNER.

3.8 SETTING PLANT MATERIALS

A. The soil shall not be worked when the moisture content is so great that excessive compaction will occur, nor when it is so dry that a dust will form in the air or that clods will not break readily. Water shall be applied if necessary to provide ideal moisture for filling and for planting as herein specified.

B. Plants shall be set in center of pits as shown in the Contract Documents. They shall be set plumb and straight, and at such a level that after settlement that the crown of the plant will be 1 to 2 inches above the finished grade.

C. Balled and burlapped trees shall have planting soil placed and compacted around base of ball to fill all voids. All burlap ropes or wires shall be removed from the sides and tops of balls.

D. All ground cover plants shall be evenly spaced, staggered in rows, and set at intervals specified, so as to produce a uniform effect. Plants shall be watered immediately after planting operations have been completed.

E. All shrubs and vines shall be pruned to remove damaged branches. All bare root shrubs shall be pruned and shaped to compensate for transplant root loss.

F. Planting soil around roots or balls shall be thoroughly compacted and watered. After planting, the soil in the shrub beds shall be cultivated between shrubs, raked smooth, and neatly outlined. Muddy soil shall not be used for backfilling. All broken or frayed roots shall be properly cut off.

G. Trees and shrubs on slopes steeper than 6 to 1 shall be provided with watering dams or berms at least 6 inches high and 8 inches wider than planting pit (hole) unless specified or shown otherwise.

H. All trees shall be thoroughly watered immediately after planting.

I. Remove all tags and labels when directed by L.A..

3.9 STAKING AND TREE WRAPPING

A. Staking of trees shall be done immediately after they are planted. Plants shall stand plumb after staking. Staking shall be as indicated on Drawings.

B. Trees 2-inch caliper and less shall be supported by 2 stakes placed diametrically opposite at perimeter line of ball and to sufficient depth to hold tree rigid. Stakes shall be driven vertically and not twisted or pulled. Trees shall be wired to each stake as indicated on Drawings.

C. All deciduous trees greater than 2-inch caliper and all evergreen trees 6'-0" and taller shall be triple staked or guyed as indicated on Drawings.

3.10 PRUNING AND MULCHING

A. Each tree and shrub shall be pruned in accordance with standard horticultural practice to preserve the natural character of the plant in the manner fitting its use in the landscape design. Prune plant material only as approved by the L.A..

B. All dead wood or suckers and all broken or badly bruised branches shall be removed by thinning out and shortening branches. Deciduous bare-rooted plants shall have not less than 1/3 of their respective leaf surfaces removed. All cuts shall be made just above a healthy bud. Pruning shall be done with clean, sharp tools.

C. Plants shall be mulched after planting and cultivating have been completed. A layer of mulch materials, as hereinbefore specified, shall be spread on finished landscaping grade within all planting areas to depths as indicated on the drawings. The mulch around isolated trees shall be 3 feet in diameter. All shrub and ground cover beds shall be completely covered with the mulch as indicated on the Drawings.

3.11 SODDING

A. Grass sod shall be provided where shown or specified and shall be maintained.

B. The soil shall be prepared and fertilized before sodding. The CONTRACTOR shall prepare only enough ground that can be planted within 24 hours thereafter.

C. Soil preparation shall consist of the following:
1. Preparation of sub-grade grading shall be per "Part 3 -- Execution" in Paragraphs entitled "General" and "Soil Preparation," herein.

D. Sod shall be cut and laid on site the same day.

E. The sod shall be placed over leveled, compacted, and prepared finish graded soil. The amended topsoil and sub-base shall be moist enough to resist shifting.

F. Sod may be placed at any time when the ground is not frozen. The surface on which the sod is to be laid should be firm and free from footprints or other depressions. A string or line of boards may be used as a guide for setting the first line of sod across the area. Sods of the next course are matched against the edge of this first line in such a way the joints between the individual sod pieces in the 2 lines do not coincide. Successive courses are matched against the last line laid, in the same manner.

G. Sod shall always be laid across slopes.

H. After sodding has been completed, the sodded area shall be cleaned up and thoroughly moistened by irrigation system.

I. Soil preparation shall consist of the following:

1. Preparation of sub-grade grading shall be per Paragraphs entitled "General" and "Soil Preparation," respectively, herein.
2. Finish grading of soil per Paragraph entitled "Soil Preparation", herein.

3.12 MISCELLANEOUS ITEMS

A. Mulch shall be placed in the planting areas as shown, spread carefully and evenly to a depths as indicated on the drawings over the entire area. Bark mulch installed in tree rings in turf areas.

B. Rock mulch shall be placed in the landscape areas as noted on plans, spread carefully and evenly to a minimum depth as noted on plans over weed barrier fabric.

END OF SECTION

SECTION 33 4100 - STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. The extent of work is indicated on the Drawings and includes the following:

1. New Cleanout Boxes and inlets and Piping.

B. The work includes but is not limited to:

Perform trenching and backfilling required for work of this Section.

1.2 RELATED SECTIONS

B. Procedures and quality of excavating, backfilling, and compacting are specified in Division 31 Section "Earthwork".

A. Concrete requirements related to this work are specified in Division 32 Section "Site Concrete."

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms regularly engaged in manufacturing of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years. Products are limited to those of domestic manufacturers.

B. Installer Qualifications: Firm with at least 3 years of successful installation experience on projects of similar scope.

C. Codes and Standards: Comply with all applicable codes and requirements, including amendments and modifications by local jurisdictions, related to the performance of this work including, but not necessarily limited to the following:

International Building Code
International Plumbing Code
International Mechanical Code
American National Standards Institute (ANSI)
American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
Welding: Qualify Welding procedures, welders, and operators in accordance with ASME b31.1, or ASME B31.9 or ANSI and ASTM as applicable, for shop and project site welding of piping work.
Utah Safety Standards (OSHA), Utah State Industrial Council

1.4 SUBMITTALS

A. Product Data: Submit manufacturers' technical data and installation instructions for each type of material precast items and product furnished.

B. Record Drawings: At project closeout, submit Record Drawings of installed utility service lines in accordance with Division 1 Requirements.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner and Architect no fewer than two days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 STORM DRAINAGE SYSTEM COMPONENTS

A. For pipe 12" diameter or larger HDPE, Corrugated PE Pipe and Fittings AASHTO M 294, Type S, with smooth waterway for coupling joints.

-Watertight Joints: Watertight joints in accordance with ASTM D 3212 and AASHTO M 252. Bell and spigot with gaskets, ASTM F477.

B. For pipe 8" diameter or smaller, PVC Pipe: ASTM D - 3035 SDR 35, with bell and spigot type joints and elastomeric seals.

C. All piping within the City ROW to be HP Storm ADS piping.

2.2 CATCH BASIN/CLEANOUT BOXES

1. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

A. Designated Precast Concrete Catch Basins: ASTM C 913, precast, reinforced

concrete; designed according to ASTM c 890 for A-16, heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.

1. Joint Sealants: ASTM C 990, bitumen or butyl rubber.

2. Grade Rings: Include 2 or 3 reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.

3. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Cast-in-Place Concrete Catch Basins: Construct of reinforced concrete; designed according to ASTM C 890 for structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Bottom Walls, and Top: Reinforced concrete.

2. Channels and Benches: Concrete.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A16. Structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum, unless otherwise indicated.

2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

PART 3 - EXECUTION

3.1 GENERAL:

A. Excavate and backfill as specified in Section 312000.

B. Locate lines as close as possible to those shown on Drawings.

C. For sloped lines, grade to obtain fall required.

D. Remove debris from trench prior to laying of pipe.

E. Do not cut trenches near footings without consulting Architect.

F. Backfill only after pipelines have been inspected and approved by Architect.

G. Failure to install joints properly shall be cause for rejection and replacement of piping system.

3.2 INSTALLATION OF STORM DRAINAGE SYSTEM

A. General: Backfill only after pipelines have been inspected and approved by Architect.

B. Install cleanout boxes to grade as indicated on plans. Provide concrete collar around new and existing boxes. Use 4,000 psi concrete collars around inlets and cleanout boxes to grade.

C. Install materials in accordance with Manufacturer's instructions.

D. Grout smooth with non-shrink grout all inlet box joints, piping connections or ledges.

3.3 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.

2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.

4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to authorities having jurisdiction.

3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.

4. Submit separate report for each test.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified

3.4 CLEANING

A. Clean interior of piping and storm drain boxes of dirt and superfluous materials.

END OF SECTION

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