
Pasadena Area Community
College District

August 8, 2025

District Design Standards Handbook

Part - 2

Prepared by

CANNONDESIGN



PASADENA CITY COLLEGE

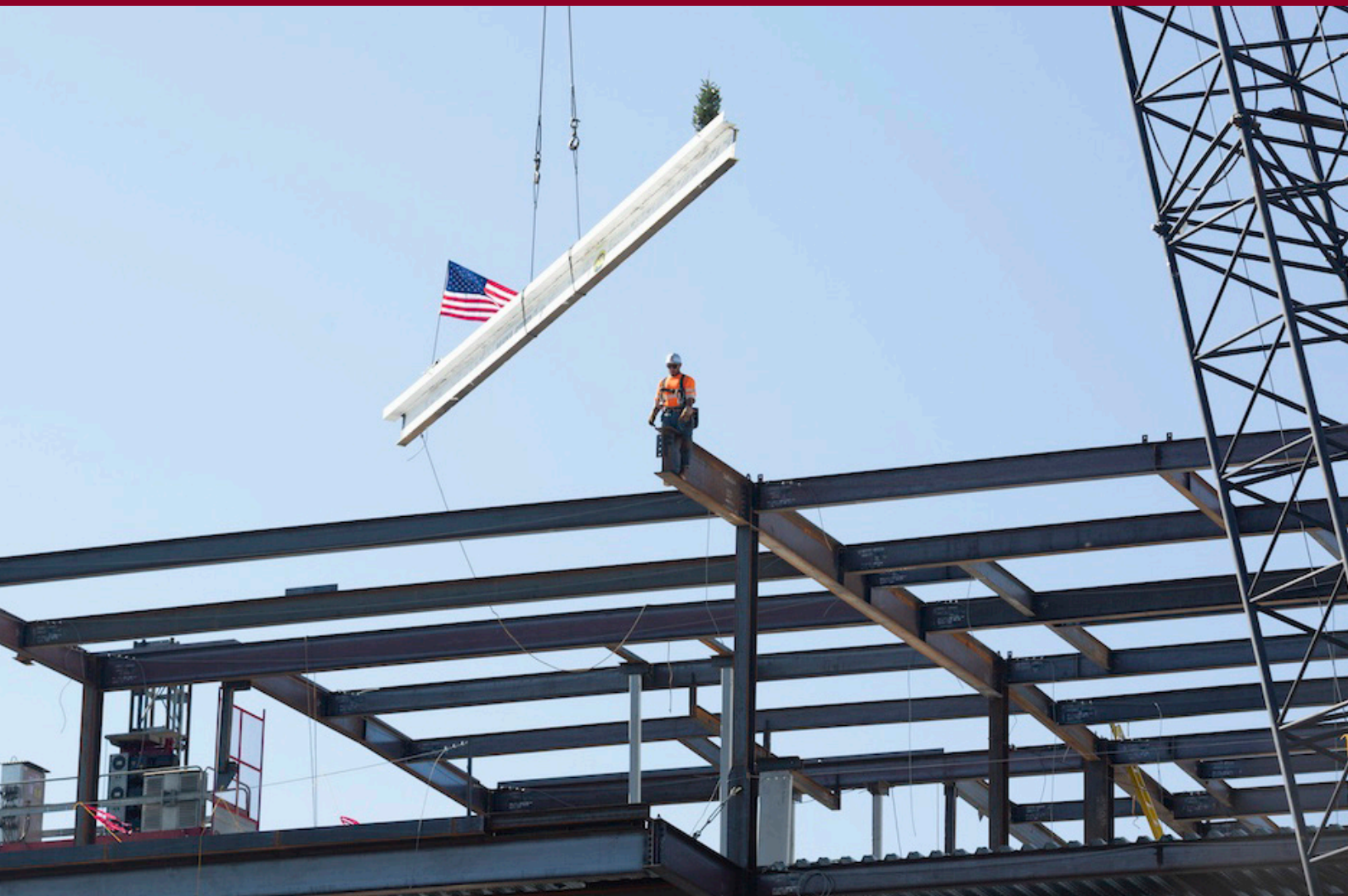


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PART - 2

2.0 **Guideline Specifications**

2.0.1 Section 000000 — General Guidelines For All Sections

2.1 Guideline Specifications **Volume 1**

2.2 Guideline Specifications **Volume 2**

SECTION 000000 – GENERAL GUIDELINES FOR ALL SECTIONS

PART 1 - GENERAL

1.1 DOCUMENT SCOPE

- A. General approach: The **Guideline Specifications** provide a framework for design professionals to use in developing project specific Project Manuals. The content was developed through multiple working sessions with District staff and represents the District's current thinking on appropriate materials and systems. That said, the District recognizes there are project specific design considerations that may suggest other options. In addition, the Design Professional is encouraged to bring forward updated materials and products as well as alternate approaches the Design Professional has found successful.
- B. The **Guideline Specifications** should be used in concert with the other District Guidelines and standards.
- C. Projects will typically include more sections than provided in the **Guideline Specifications**. The reasons for these omissions are:
 - 1. Division 01 Sections are not included. These are best developed for each project, and should reflect the project delivery method, project scope, and District procurement requirements.
 - 2. Many omitted sections were considered project specific, and should be developed as needed. For example, demolition and most structural sections are not included.
- D. The **Guideline Specifications** can be used for multiple project delivery methods, including Design Build.
- E. Many of the District projects are subject to regulations established by the Division of the State Architect (DSA). However, some project types are exempt. The **Guideline Specifications** include references to DSA and Title 24 regulations; adjust those as applicable when projects are developed using local regulations.

1.2 SECTION STRUCTURE

- A. General approach: Each section is based on the AIA Masterspec, with customized language reflecting District preferences or consultant recommended practice. Each Design Professional will evaluate the project specific requirements and edit as appropriate. The content should not be used as-is without verification with the District and only after professional exercise of the standard of care.
- B. Part 1: The **Guideline Specifications** Part 1 is limited to a basic scope description. All other Part 1 content would be added as appropriate to the project.
- C. Part 2: Based on review with the District, materials, products and systems are indicated. These reflect District preference or agreement with the content.
- D. Part 3: The **Guideline Specifications** do not include Part 3. All Part 3 content would be added as appropriate to the project

1.3 GUIDELINES

- A. Most sections in Volume 1 include an italicized "Guidelines" following the title. This content often reflects the rationale for the Section content, and guidance on making selections. These also provide reminders on other section content, such as quality control, submittals and other project specific elements.

1.4 SECTION NOTATION

- A. Most Design professionals will recognize the use of bracketed text to identify choices. Many Sections will require those selections on a project specific basis. For example, Section 033543 Polished Concrete Finishing includes the following (italics added):

"B. Polishing Standard: Provide polished concrete finish meeting aggregate exposure, sheen and haze standards as published by the ASCC Concrete Polishing Council (CPC) and the following definitions.

1. Aggregate Exposure Class: Visual observation of polished floor aggregate surface exposure area after grinding and polishing operations. Aggregate exposure class ranges are [A], [B], and [C]."

- B. In this example, the Design Professional, based on their understanding of the referenced standard, would select A, B, or C as appropriate for the design.

1.5 PROPRIETARY SPECIFICATION

- A. The District is bound by multiple statutes and regulations affecting public bidding, including the California Public Contract Code Section 3400. The statute inserts by law the term "or equal" unless the District has complied with requirements for "sole sourcing".

- B. Avoid specifying a sole sourced product or material without verifying compliance with PCC Section 3400 with the District.

- C. When manufacturers are listed, the **Guideline Specifications** use not only "or equal" language but also language that provides an open specification, such as (Italics added):

"Basis-of-Design Products: Subject to compliance with requirements, provide one of the products listed in the "Polished Concrete Schedule" or an acceptable comparable product from one of, but not limited to, the following:

- 1. Curecrete.*
- 2. Prosoco.*
- 3. Ardex."*

1.6 SUSTAINABILITY.

- A. The **Guideline Specifications** do not typically address sustainability content. Each project will apply the District's standards as applicable to the specific project.

- B. In addition, compliance with Title 24 Part 11 (CalGreen) regulations, such as VOC content and GWP, is required as applicable.

END OF SECTION 000000

2.1

Guideline Specifications Volume 1: Div 03-14





PASADENA AREA COMMUNITY COLLEGE DISTRICT

District Standards and Guidelines

CannonDesign Project Number 007459.00

Project Manual Guideline Specifications Version 01

Volume 1 Divisions 03 through 14

August 8, 2025

CANNONDESIGN

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Author Legend

Abbreviation	Firm	Discipline
CD	CannonDesign	Architectural
CD	CannonDesign	Mechanical
CD	CannonDesign	Electrical
CD	CannonDesign	Plumbing
CD	CannonDesign	IT
CD	CannonDesign	Security
		Owner

Issue Legend

Abbreviation	Title	Date
Draft 1	Standards and Guidelines Draft 1	March 24, 2025
Draft 2	Standards and Guidelines Draft 2	May 27, 2025
Draft 3	Standards and Guidelines Draft 3	June 06, 2025
Final	Standards and Guidelines Final	August 08, 2025

Notes:

1. Sections without a date will be included in a future issuance.
2. **Bold section number, title, author, and date** indicates a **revised** or **new** section.
3. Text that is ~~struck out~~ indicates a deleted section.

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	DIVISION 02 – EXISTING CONDITIONS NOT INCLUDED AT THIS TIME		
	DIVISION 03 – CONCRETE		
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SECTION 033543 - POLISHED CONCRETE FINISHING

GUIDELINES

1. *Polished concrete is dependent on concrete mix characteristics. Review recommended criteria with team and verify consultant sections comply:*
 - a. *Minimum Concrete Compressive Strength: 3500 psi; Normal Weight Concrete (light weight structural concrete mix is not recommended; Use non-air entrained mix; Use mix with no fly ash.*
 - b. *finish slab to ACI 302.1R, Class 5, with no burn marks.*
 - c. *Ff overall 50/local 35.*
 - d. *curing options per polishing products manufacturer - avoid sheet membrane cure. Use dissipating curing compounds.*
2. *Degree of aggregate exposure (cut) and image clarity (sheen) is defined by referenced standard. Choose option based on design.*
3. *Some combination of Mockup, sample panel and reference samples are recommended.*
4. *Slab protection is critical both before and after polishing. Particular concern for dripping oil from equipment such as pipe threading.*
5. *Polished concrete product manufacturers have typically reported slip COF using the ANSI NFS B101.3 test, very similar to the ANSI A326.3 test. Static testing value of 0.50 typically used by UL/OSHA should not be considered safe. Require dynamic testing (DCOF) using either ASTM E303 Pendulum Test or ANSI A326.3. Pendulum test provides more discrete categories and is used in all other countries except US. If ANSI A326.3 is used, note that polished concrete product manufacturers do not currently provide "Declared Use Classification" values as required for ceramic tile manufacturers. Values indicated in this document are options – select as appropriate. Field testing of completed work recommended*
6. *Polishing process can include use of stain. Review manufacturers literature for fade resistance and VOC compliance.*
7. *Concrete cracking should be expected. Require increased number of shrinkage control slab joints and develop a protocol for repairing cracking in spite of joints.*
8. *Select sealant in joints with high Shore A value.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Polished concrete finishing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Slip Resistance Characteristics: For polished concrete flooring products, as determined by testing identical products according to ANSI A326.3 by a qualified testing agency
 1. Dynamic Coefficient of Friction; COF AcuTest, ANSI A326.3: Not less than the following:
 - a. Interior, Wet (IW): Level Surfaces: [0.42] [0.60].
 - b. Interior, Wet Plus (IW+), Shower floors, Staff Lounges, ground floor lobbies: 0.65.
 - c. Exterior, Wet (EW), Level Surfaces: [0.055] [0.65] [0.80]
 - d. Exterior and Interior ramps and inclines: Minimum [0.65] [0.80].
 - e. Oils/Greases (O/G): Minimum [0.65] [0.80].

2. Dynamic Coefficient of Friction; DCOF ASTM E 303: Not less than the following:
 - a. Interior floors: Minimum 36.
 - b. Interior Shower floors, Staff Lounges, ground floor lobbies: Minimum 36.
 - c. Exterior, Level Surfaces: Minimum 45
 - d. Serving areas, swimming pool surrounds, locker room shower rooms: Minimum 45
 - e. Exterior and Interior ramps and inclines: Minimum 54.
 - f. Oils/Greases, commercial kitchens: Minimum 54.
- B. Polishing Standard: Provide polished concrete finish meeting aggregate exposure, sheen and haze standards as published by the ASCC Concrete Polishing Council (CPC) and the following definitions.
 1. Aggregate Exposure Class: Visual observation of polished floor aggregate surface exposure area after grinding and polishing operations. Aggregate exposure class ranges are [A], [B], and [C].
 2. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of polished concrete.
 3. Distinctness of Image (DOI): The distinctness (clarity) of images reflected by the glossy coating surface appearance of the polished concrete finish appearance levels. The transmission of this reflection is measured in accordance with ASTM D5767 and defined as Polish Concrete Appearance Level [1][2][3][4].
 4. Haze: The cloudiness or milky appearance of images from objects produced by reflection in a polished concrete surface. The measurement of this appearance is defined in accordance with ASTM D4039. The test method reading is put into a calculation resulting in a Haze Index value.
 5. Specular Gloss: A reflectance value determined by a single measurement of gloss from shining a known amount of light at a surface within a specific angle of illumination in accordance with ASTM D523.

2.2 MANUFACTURERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide one with the products listed in the "Polished Concrete Schedule" or an acceptable comparable product from one of, but not limited to; the following:
 1. Curecrete.
 2. Prosoco.
 3. Ardex.

2.3 ACCESSORIES

- A. Repair Materials: As recommended in writing by manufacturer to repair and fill cracks and repair surfaces compatible with polishing materials.
- B. Water: Potable.
- C. Cleaning Agents: As recommended in writing by manufacturer.

2.4 POLISHING EQUIPMENT

- A. Equipment and Supplies: Provide equipment and supplies, not limited to, the concrete grinding and concrete polisher equipment, tooling and polishing diamonds for the polished concrete finishing Work.

2.5 POLISHED CONCRETE SCHEDULE

- A. PCF-#: Normal weight concrete.
 - 1. Basis-of-Design System: Advanced Floor Products; Curecrete.
 - 2. Liquid Floor Treatment: Stain Protector.
 - 3. Finish:
 - a. Aggregate Exposure Class: [A][B][C].
 - b. Polish Concrete Appearance Level: Level [1][2][3][4].
 - 4. Joint Filler: Advanced Floor Products; CreteFill.
 - a. Shore A Value: [65][75][85].

PART 3 - EXECUTION - NOT USED

END OF SECTION 033543

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SECTION 051213 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

GUIDELINES

1. *AESS is defined by AISC Standards and represents increasingly refined quality requirements for the steel and its fabrication. Identified as Categories, Category AESS 1, 2 and 3 increase the quality based on viewing distance and detailing, with AESS 1 representing a lesser quality than 2 or the highest at AESS 3. (AESS 4 is artisan level).*
2. *The standard also includes a Category C for Custom. This can be used for assigning custom detailing and quality requirements. It also can be used to define specific project areas, such as certain beam to column conditions that are to be fabricated using AESS 1, 2 or 3. These conditions are typically identified on the drawings. This avoids a blanket application to all exposed steel applications.*
3. *Establish clear samples and mockup requirements. Define if "first-in-place" conditions can serve as a mockup. Samples and mockups should be produced with final finish, including intumescent for exposed conditions. Members in all samples and mockups should extend at least 6 inches from the joint.*
4. *Apply installation criteria as appropriate.*
5. *AESS is an expensive decision, and increasing the quality level from AESS 1 to AESS 3 can result in exponential costs. Be aware of cost and schedule ramifications.*

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Architecturally exposed structural steel (AESS).
2. Section 051200 "Structural Steel Framing" requirements unless otherwise modified by specified AESS conditions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with requirements of ANSI/AISC 303, Sections 1 through 9, as modified in Section 10, "Architecturally Exposed Structural Steel.", and as specified in this Section.
- B. Comply with specified categories
 1. AESS: Architecturally exposed structural steel.
 2. Category: Structural steel categorized by ANSI/AISC 303, Section 10, as AESS
 3. Exterior Steel Application <Define>: Category AESS [1][2][3][C].
 4. Interior Steel Application <Define>: Category AESS [1][2][3][C].

2.2 FILLER

- A. Polyester filler intended for use in repairing dents in automobile bodies.

2.3 PRIMER

- A. Steel Primers:
 1. Comply with Section 099123 and Section 099600 as applicable for location.
- B. Galvanized-Steel Primer: Comply with Section 099600.
 1. Galvanizing Repair Paint: ASTM A780/A780M.

2.4 FABRICATION

- A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.
 - 1. Use special care handling and fabricating AESS before and after shop painting to minimize damage to shop finish.
- B. Category AESS 1:
 - 1. Provide AESS as specified at exposed to view structural steel locations.
 - 2. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - 3. Prepare surfaces according to Part 2 "Shop Priming" Article.
 - 4. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
 - 5. Welds
 - a. Provide continuous welds, uniform size and profile.
 - b. Weld profiles, quality, and finish to be as approved by Architect.
 - c. Make joint welds, including tack welds, appear continuous by filling intermittent welds.
 - d. Oversize welds where ground, contoured, or blended, and grind to provide a smooth transition, matching profile approved by Architect.
 - 6. Seal weld open ends of hollow structural sections with 3/8-inch closure plates.
 - 7. Align bolt holes, maintain consistent spacing, orient bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
 - 8. Remove weld spatter, slivers, and similar surface discontinuities.
 - 9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
 - 10. Remove backing and runoff tabs, and grind welds smooth.
- C. Category AESS 2:
 - 1. Provide AESS as specified at exposed to view structural steel locations.
 - 2. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - 3. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
 - 4. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
 - 5. Make intermittent welds appear continuous, using filler or additional welding.
 - 6. Seal weld open ends of hollow structural sections with 3/8-inch closure plates.
 - 7. Limit butt and plug weld projections to 1/16 inch.
 - 8. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
 - 9. Remove weld spatter, slivers, and similar surface discontinuities.
 - 10. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
 - 11. Grind tack welds smooth unless incorporated into final welds.
 - 12. Remove backing and runoff tabs, and grind welds smooth.
 - 13. Limit as-fabricated straightness tolerance to one-half that permitted for structural-steel materials in ANSI/AISC 303.
 - 14. Limit as-fabricated curved structural steel tolerance to that permitted for structural-steel materials in ANSI/AISC 303.

15. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
 16. Conceal fabrication and erection markings from view in the completed structure.
 17. Make welds uniform and smooth.
- D. Category AESS 3:
1. Provide AESS as specified at exposed to view structural steel locations.
 2. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 3. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
 4. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
 5. Make intermittent welds appear continuous, using filler or additional welding.
 6. Seal weld open ends of hollow structural sections with 3/8-inch closure plates.
 7. Limit butt and plug weld projections to 1/16 inch.
 8. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
 9. Remove weld spatter, slivers, and similar surface discontinuities.
 10. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
 11. Grind tack welds smooth unless incorporated into final welds.
 12. Remove backing and runoff tabs, and grind welds smooth.
 13. Limit as-fabricated straightness tolerance to one-half that permitted for structural-steel materials in ANSI/AISC 303.
 14. Limit as-fabricated curved structural steel tolerance to that permitted for structural-steel materials in ANSI/AISC 303.
 15. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
 16. Conceal fabrication and erection markings from view in the completed structure.
 17. Make welds uniform and smooth.
 18. Cut out mill marks from mill material or hide these markings from view in the completed structure. Where neither method is possible, remove mill marks by grinding and filling surfaces as approved by Architect.
 19. Grind butt and plug welds smooth or fill, removing weld splatter exposed to view.
 20. Orient HSS seams as indicated or away from view.
 21. Align and match abutting member cross sections.
 22. At visible open joints of copes, miters, and cuts, maintain uniform clear gaps of 1/8 inch. At closed joints, maintain uniform contact within 1/16 inch.
 23. Fabricate with exposed surfaces smooth, square, and of surface quality approved by Architect.
- E. Category AESS C (*Example language*):
1. *Provide AESS Category 3 at all beam to column connections along Gridline B.*
 2. *Provide AESS Category 2 at all braced frame to column connections.*
- F. Erection marks, painted marks, and other marks are permitted on galvanized- steel surfaces of completed structure.
- G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
4. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.

PART 3 - EXECUTION – NOT USED

END OF SECTION 051213

SECTION 055000 - METAL FABRICATIONS

GUIDELINES

1. *Metal Fabrications covers a wide range of conditions and can include some structural applications.*
2. *Examples shown in this Section are representative; add as necessary.*
3. *Most project manuals include fabrications as well as manufactured products, such as ladders.*
4. *Depending on application, delegated design obligation complying with specified criteria is not unusual.*
5. *There may be fabrications that can use AESS Categories as referenced in Section 051213.*
6. *Slotted Channel framing (Uni-Strut) is included in this section.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes, but not necessarily limited to, the following:
 1. Miscellaneous framing and supports.
 2. Slotted Channel framing systems
 3. Cylinder Tank Restraint Framing.
 4. Metal ladders.
 5. Ladder Safety System.
 6. Miscellaneous steel trim.
 7. Metal bollards.
 8. Abrasive metal nosings, treads, and thresholds.
- B. Products furnished, but not installed, under this Section include the following:
 1. Loose steel lintels.
 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Aluminum Ladders: Ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
 1. Allowable Fastener Loads: Coordinate with substrate and framing systems to determine fastener types and sizes and required minimum thicknesses of substrate framing members required for fastener pull-out resistance.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- E. Slotted Channel Framing: Cold-formed metal box channels with continuous slot complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches.
 - 2. Cold-rolled, Steel: ASTM A1008/A1008M, structural steel, Grade 33; 0.0966-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum and stainless steel.
 - 2. Provide bronze fasteners for fastening bronze.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
 - 1. Provide hot-dip galvanize or provide mechanically deposited, zinc-coated anchor bolts coating where item being fastened is indicated to be galvanized.
- D. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488, conducted by a qualified independent testing agency.
- E. Post-Installed Anchors: Torque-controlled expansion anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- F. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

- A. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

- B. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.5 SHOP PRIMERS

- A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- B. Zinc-Rich Primer: Provide zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat, at all exterior steel framing and support elements.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Tnemec Company, Inc.; Tneme-Zinc 90-97.
- C. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

2.6 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
 - 5. *Where indicated, comply with AESS Category C per Section 051213.*
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated and coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts if units are installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports in exterior wall assemblies and outside the building envelope.
- D. Prime interior miscellaneous framing and supports with universal primer or water-based primer for fabrications to receive a high-performance coating as specified in Section 099600 "High-Performance Coatings."

2.8 SUSPENDED GRID

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Unistrut Building Systems; Unistrut.
- B. Materials: Minimum 12 gage galvanized steel channels and fittings to form a grid capable of adequately supporting equipment indicated.
- C. Fabrication: Provide suspended grid system complete with all required framing members, fittings, fasteners, threaded rods, closure strips, etc., and designed to accommodate all stationary and rolling loads of equipment.
 - 1. Consult with equipment supplier(s) to determine structural requirements and design system to meet those requirements.
 - 2. Provide delegated design calculations by suspended grid manufacturer that have been prepared by a licensed structural engineer.

2.9 METAL LADDERS

- A. General:
 - 1. Comply with ANSI A14.3.
- B. Aluminum Ladders:
 - 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. O'Keeffe's Inc.
 - b. UPNOVR, Inc.
 - 2. Source Limitations: Obtain aluminum ladders from single source from single manufacturer.
 - 3. Space siderails 18 inches apart unless otherwise indicated.

4. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.
5. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.
6. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.
7. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted aluminum brackets.
8. Provide minimum 72-inch- high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

2.10 LADDER SAFETY SYSTEM

- A. Delegated Design: Ladder Safety System to be designed in accordance with OSHA 1910.29 Ladder Safety System.
- B. Fabricate ladder safety system to comply with ANSI A14.3. Assemble components with stainless steel fasteners, brackets, and clamps. Provide ladder safety system permanently attached to ladder with uninterrupted fall protection.
 1. Top bracket with deceleration device.
 2. Carrier: Stainless steel cable.
 3. Pass-through cable guide: Automatic.
 4. Bottom bracket with tensioner.

2.11 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 80 steel pipe.
 1. Cap bollards with 1/4-inch- thick, steel plate with flat top.
 2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
 3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.
- B. Fabricate sleeves for bollard anchorage from steel or stainless steel pipe with 1/4-inch- thick, steel or stainless-steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.
- C. Fabricate internal sleeves for removable bollards from Schedule 80 steel pipe with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4-inch stainless steel machine bolt.
- D. Galvanize steel bollards. Prime with zinc-rich primer or water-based primer for fabrications to receive a high-performance coating as specified in Section 099600 "High-Performance Coatings."

2.12 FABRICATED GATE HARDWARE AND COMPONENTS

- A. Fabricated gates
 1. Provide hardware as specified in Section 087100
 2. Fabricate steel box for all locking mechanisms.
 3. Mount hardware at minimum 30 inches, maximum 44 inches above grade.
 4. Provide continuous panel on each side at bottom of each gate panel, minimum 10 inches high, 1/8-inch thick, galvanized sheet steel, welded to gate frame. Ease all edges. Provide maximum 3-inch gap between gate bottom and finish grade.
 5. Fabricate steel box for all locking mechanisms.

6. Mount hardware at minimum 30 inches, maximum 44 inches above grade.
7. Provide continuous panel on each side at bottom of each gate panel, minimum 10 inches high, 1/8-inch thick, galvanized sheet steel, welded to gate frame. Ease all edges. Provide maximum 3-inch gap between gate bottom and finish grade.

2.13 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

- A. Extruded Units: Aluminum, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in sizes and configurations indicated and lengths necessary to accurately fit openings or conditions.
 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. Wooster Products Inc.
 2. Source Limitations: Obtain units from single source from single manufacturer.
 3. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
 4. Provide solid-abrasive-type units without ribs.
 5. Nosings:
 - a. Square-back units, 3 inches wide, for casting into concrete steps.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
 1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.
- D. Apply bituminous paint to concealed surfaces of cast-metal units.
- E. Apply clear lacquer to concealed surfaces of extruded units.

2.14 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.15 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.
- C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.16 STEEL AND IRON FINISHES

- A. Galvanizing: Hot dip galvanize items as indicated to comply with applicable standard listed below:
 1. ASTM A153 for steel and iron hardware

2. ASTM A123 for other steel and iron products.
 3. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
1. Shop prime with universal shop primer unless zinc-rich or water-based primer is indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
 5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- 2.17 ALUMINUM FINISHES
- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. As-Fabricated Finish: AA-M12.
- C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION – NOT USED

END OF SECTION 055000

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SECTION 055113 - METAL PAN STAIRS, RAILINGS AND GUARDS

GUIDELINES

1. *Verify design scope is defined between SEOR and Architect for railing and guard design.*
2. *Confirm material finishes and AESS criteria.*
3. *Evaluate if stair assembly is protected from weather. Galvanized or not, water will accumulate within the pan and rust the stair assembly. Use alternate tread design, such as open grating or epoxy finished tread.*
4. *Consider using precast concrete tread and risers at exterior conditions or for design effect.*
5. *Define guard design and transitions, including pickets, perforated panels or mesh.*
6. *Select nosing based on finish materials and CBC.*

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel stairs with concrete-filled and treads.
2. Steel railings and guards attached to metal stairs.
3. Steel handrails attached to walls adjacent to metal stairs.
4. Steel Guard Assemblies
5. Railing gates at the level of exit discharge.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

B. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

- a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

- C. Seismic Performance of Stairs: Metal stairs withstand the effects of earthquake motions determined according to ASCE/SEI 7 as modified by CBC Chapter 16A.

1. Component Importance Factor: <Insert requirement>.

2.2 METALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing for Guards: ASTM A500/A500M (cold formed).
 1. Provide galvanized finish for exterior installations and where indicated.
- D. Steel Pipe for Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight, unless another grade and weight are required by structural loads.
 1. Provide galvanized finish for exterior installations and where indicated.
- E. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.
- F. Galvanized Steel Sheet: ASTM A653/A653M, G90 coating, either commercial steel, Type B, or structural steel, Grade 33, unless another grade is required by design loads.
- G. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

2.3 ABRASIVE NOSINGS

- A. Extruded Units: Aluminum units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
 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. Wooster Products Inc.
 2. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
 3. Nosings, Square-Back Units: 3 inches wide, without lip.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.
- D. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

2.4 STAINLESS STEEL RAILING

- A. Tubing: ASTM A 554, Grade MT 304.
- B. Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
- C. Finish: No. 4.

2.5 HANDRAIL BRACKETS

- A. Handrail Wall Brackets: Cast stainless steel, center of rail 2-1/2 inches from face of wall.
 - 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. CRL
 - b. Or equal.
 - 2. Series: Pismo HR15B4BS

2.6 GUARD AND INFILL PANELS:

- A. Perforated Panels
 - 1. Fabricate infill panels from perforated steel plate.
 - 2. Thickness: As indicated on drawings.
 - 3. Perforation Pattern: As indicated on drawings.
 - 4. Ease all panel edges.
 - 5. Finish: ASTM A653/A653M, G90 coating, finish painted per Section 099113.

2.7 FASTENERS

- A. General: Provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5 where built into exterior walls.
 - 1. Select fasteners for type, grade, and class required.
- B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated and capable of withstanding design loads.
- C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
 - 1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs.
- E. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.8 MISCELLANEOUS MATERIALS

- A. Welding Electrodes: Comply with AWS requirements.
- B. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting." Section 099600 "High-Performance Coatings."
- C. Zinc-Rich Primer: Comply with SSPC-Paint 20, , Level , and compatible with topcoat.

- D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish system indicated.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with ASTM A780/A780M and compatible with paints specified to be used over it.
- F. For galvanized reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.9 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, railings and guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs, railings, and guards in shop to greatest extent possible.
 - 1. Disassemble units only as necessary for shipping and handling limitations.
 - 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Weld exposed corners and seams continuously unless otherwise indicated.
 - 5. Provide full length welds at all pan edges, ground smooth.
 - 6. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of welded joint] [Finish #2 - Completely sanded joint with some undercutting and pinholes okay] [Finish # 3 - Partially dressed weld with spatter removed] [Finish # 4 - Good quality, uniform undressed weld with minimal splatter].
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
 - 2. Locate joints where least conspicuous.
 - 3. Fabricate joints that will be exposed to weather in a manner to exclude water.
 - 4. Provide weep holes where water may accumulate internally.

2.10 FABRICATION OF STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Class, unless more stringent requirements are indicated.
 - 1. *Comply with AESS Category 3 per Section 051213.*
- B. Stair Framing:
 - 1. Stringers: Fabricate of steel channels.
 - a. Stringer Size: As indicated on Drawings.
 - b. Provide closures for exposed ends of channel and rectangular tube stringers.
 - c. Finish: Shop primed.
 - 2. Platforms: Construct of steel channel headers and miscellaneous framing members as required to comply with "Performance Requirements" Article.
 - a. Provide closures for exposed ends of channel and rectangular tube framing.
 - 3. Weld stringers to headers; weld framing members to stringers and headers.
 - 4. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- C. Metal Pan Stairs: Form risers, sub tread pans, and sub platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch.
 - 1. Fabricate treads and landing sub platforms of exterior stairs so finished walking surfaces slope to drain.
 - 2. Steel Sheet, Uncoated: Cold-rolled steel sheet unless otherwise indicated.
 - 3. Galvanized Steel Sheet: Galvanized steel sheet, where indicated.
 - 4. Directly weld metal pans to stringers; locate welds on top of sub treads where they will be concealed by concrete fill. Do not weld risers to stringers.
 - 5. Shape metal pans to include nosing integral with riser.
 - 6. Provide sub platforms of configuration indicated or, if not indicated, the same as sub treads. Weld sub platforms to platform framing.
 - a. Smooth Soffit Construction: Construct sub platforms with flat metal under surfaces to produce smooth soffits.

2.11 FABRICATION OF STAIR RAILINGS AND GUARDS

- A. Comply with applicable requirements in fabrication of railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.
 - 1. Rails and Posts: 1-5/8-inch- diameter top and bottom rails and 1-1/2-inch- square posts.
 - 2. Picket Infill: 3/4-inch- round pickets spaced to prohibit the passage of a 4-inch diameter sphere.
 - 3. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with **[cam-type, self-closing] [spring]** hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

- B. Welded Connections: Fabricate railings and guards with welded connections.
 - 1. Fabricate connections that are exposed to weather in a manner that excludes water.
 - a. Provide weep holes where water may accumulate internally.
 - 2. Cope components at connections to provide close fit or use fittings designed for this purpose.
 - 3. Weld all around at connections, including at fittings.
 - 4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 5. Obtain fusion without undercut or overlap.
 - 6. Remove flux immediately.
 - 7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of a welded joint as shown in NAAMM AMP 521.
 - C. Form changes in direction of railings and guards as follows:
 - 1. By bending.
 - 2. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
 - D. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
 - E. Close exposed ends of railing and guard members.
 - F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.
 - 1. Close ends of returns.
 - G. Connect posts to stair framing by direct welding unless otherwise indicated.
 - H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.
 - 1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
 - 2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
 - 3. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanized anchors embedded in exterior masonry and concrete construction.
 - 4. Provide type of bracket with predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.
 - I. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.
 - 1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.
- 2.12 FINISHES
- A. Finish metal stairs after assembly.
 - B. Galvanizing: Hot dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. Preparation for Shop Priming: Prepare uncoated, ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."
- D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION – NOT USED

END OF SECTION 055113

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SECTION 055213 - PIPE AND TUBE RAILINGS

GUIDELINES

1. *Verify design scope is defined between SEOR and Architect for railing and guard design.*
2. *Confirm material finishes and AESS criteria.*
3. *Review use of stainless-steel railing option to reduce maintenance.*
4. *Define guard design and transitions, including pickets, perforated panels or mesh.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Steel railings not included with Section 055113.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf. / ft. applied in any direction.
 - b. Concentrated load of 200 lbf. applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.3 HANDRAIL BRACKETS

- A. Handrail Wall Brackets: Cast stainless steel, center of rail 2-1/2 inches from face of wall.
 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. CRL
 - b. Or equal.
 2. Series: Pismo HR15B4BS

2.4 STEEL RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- C. Tubing: ASTM A500/A500M (cold formed) ASTM A513/A513M, Type 5.
- D. Stainless-Steel Strip, Plate, and Flat Bars: ASTM A 666, Type 304, unless noted otherwise.
- E. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- F. Stainless steel tubing and fittings: ASTM A 213/269, Type 304, Schedule 80, no. 4 finish, unless noted otherwise.
- G. Stainless steel sheets: ASTM A 240, Type 304, minimum 20 gage, no. 4 finish, unless noted otherwise.
- H. Expanded Metal Infill Panels: ASTM F1267, [Type I (expanded)] [Type II (expanded and flattened)], Class 1 (uncoated).
- I. Perforated-Metal Infill Panels:
 - 1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel, Type B, minimum 0.125 inch thick.
 - 2. Pattern: Provide perforated steel guard panels, descending gradient pattern from 75 percent to 50 percent openness, with 1 inch margin at all edges.
- J. Woven-Wire Mesh Infill Panels: Intermediate-crimp, square pattern, 2-inch woven-wire mesh, made from 0.134-inch- diameter steel wire complying with ASTM A510.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
 - 1. For stainless steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting ", Section 099123 "Interior Painting.", Section 099600 "High-Performance Coatings" as applicable.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Bituminous Paint: Cold-applied asphalt emulsion, complying with ASTM D1187/D1187M.
- G. Non-shrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

- H. Anchoring Cement: Factory-packaged, non-shrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Product: At exterior locations, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturers for exterior use.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 - 1. Clearly mark units for reassembly and coordinated installation.
 - 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
 - 1. Provide weep holes where water may accumulate.
 - 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with cam-type, self-closing hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.
- I. Welded Connections: Cope components at connections to provide close fit or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [Finish #1 welds; ornamental quality with no evidence of a welded joint] [Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay] [Finish #3 welds; utilitarian appearance not subject to view, partially dressed weld with spatter removed].
- J. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- K. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.

- L. Form changes in direction as follows:
 - 1. As detailed.
 - 2. By radius bends of radius indicated.
 - 3. By bending to smallest radius that will not result in distortion of railing member.
 - M. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
 - N. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
 - O. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
 - P. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
 - Q. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
 - 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 - 2. Coordinate anchorage devices with supporting structure.
 - R. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.
 - S. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.
 - 1. Provide socket covers designed and fabricated to resist being dislodged.
 - 2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
 - T. Guard Infill Panels: Fabricate infill panels from [expanded-metal sheet] [perforated metal sheet][woven wire mesh].
 - 1. Edge panels with U-shaped channels made from metal sheet, of same metal as guard and not less than 0.043 inch thick.
 - 2. Orient expanded metal with long dimension of pattern [parallel to top rail] [perpendicular to top rail] [horizontal] [vertical].
 - U. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.
- 2.7 STEEL AND IRON FINISHES
- A. Galvanized Railings:
 - 1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
 - 2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
 - 3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
 - 4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner and as follows.
 1. Comply with SSPC-SP 16.
- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.

2.8 ALUMINUM FINISHES

- A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Powder-Coat Finish: AAMA 2605 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.9 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: No. 4 finish, grind and polish surfaces to produce uniform finish, free of cross scratches.
 1. Run grain with long dimension of each piece.
 2. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION - NOT USED

END OF SECTION

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SECTION 055813 - COLUMN COVERS

GUIDELINES

1. *Select seam system based on design approach.*
2. *Verify finish system used meets required durability conditions.*
3. *Consider use of GFRC column covers.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes [spackled-seam][snap-together] metal column covers.

PART 2 - PRODUCTS

2.1 SPACKLED-SEAM COLUMN COVERS

- 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. Fry Reglet Corporation.
 2. MM Systems Corporation.
 3. Pittcon Industries.
- B. Form column covers from 0.125-inch aluminum sheet complying with ASTM B 209, with not less than strength and durability properties of Alloy 5005-H32; rolled to radii indicated. Taper edges of adjoining pieces of column covers, for taping and spackling, to 0.094-inch thickness in approximately 1 inch of width. Punch tapered edges for gypsum board screws at 1/2 inch o.c., and mill grooves in tapered edge to improve bond with joint compound.
1. Support Framing: At vertical joints, provide 1-1/2-by-3-5/8-inch steel channel support posts formed from 0.040-inch galvanized steel.
 2. Joint Treatment Materials: Provide joint treatment compounds and reinforcing tape complying with requirements in Section 092900 "Gypsum Board."

2.2 SNAP-TOGETHER COLUMN COVERS

- 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. ATAS International, Inc.
 2. Fry Reglet Corporation.
 3. Pittcon Industries.
- B. Form column covers to shapes indicated from metal of type and minimum thickness indicated below. Return vertical edges and bend to form hook that engages continuous mounting clips.
1. Aluminum Sheet: ASTM B 209, with not less than strength and durability properties of Alloy 5005-H32, 0.063 inch thick.
 - a. Finish: High-performance organic coating.
 2. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, 0.050 inch thick.
 - a. Finish: No. 4.

3. Column covers may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
4. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide flat surfaces where indicated.
5. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
6. Form returns at vertical joints to provide hairline V-joints.
7. Fabricate column covers with hairline horizontal V-joints produced by forming returns on mating ends of column cover sections. Locate horizontal joints as indicated.
8. Fabricate base ceiling ring to match column covers.
9. Fabricate with calk stop/stiffener ring.
10. Apply manufacturer's recommended sound-deadening insulation to backs of column covers.

2.3 MISCELLANEOUS MATERIALS

- A. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.
 1. Provide concealed fasteners for interconnecting column covers and for attaching them to other work unless otherwise indicated.
 2. Provide square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.
- B. Sound-Deadening Materials:
 1. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C 665, Type I, and passing ASTM E 136 test.
- C. Backing Materials: Provided or recommended by column cover manufacturer.

2.4 FABRICATION, GENERAL

- A. Coordinate dimensions and attachment methods of column covers with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.
- B. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends.

2.5 GENERAL FINISH REQUIREMENTS

- A. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
- D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.7 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Directional Satin Finish: No. 4.

PART 3 - EXECUTION - NOT USED

END OF SECTION

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SECTION 057313 - GLAZED DECORATIVE METAL RAILINGS

GUIDELINES

1. *Verify design scope is defined between SEOR and Architect for railing and guard design. Use of railing system with ICC ESR is critical to avoid extensive DSA design review.*
2. *Confirm material finishes.*
3. *Evaluate glass options. Section is built on laminated glass using Saflex laminate film for strength. PVB interlayer may be appropriate in certain thicknesses.*
4. *Fully tempered monolithic glass with adequate thickness may be acceptable. Laminated is preferred approach to avoid glass shower on persons below if shattered. Laminate stays in place. Laminate is required if railing is in windborne debris region.*
5. *Select bracket type, anchorage, exposure, railing material and bracket based on design.*
6. *Sample and in some cases mockups are important for review of base and stainless steel welding.*

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glazed decorative metal railings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Railings, including attachment to building construction, are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Structural Glass Railings and Glass-Infill Panels:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.
 3. For structural glass railings, support each section of top rail and handrail by a minimum of three glass panels or by other means so railings will remain in place if any one glass panel fails.
 - a. Support top rail and handrail ends such that railings remains in place if end glass panel fails.
- B. Wind Loads: For exterior glazed decorative metal railings, capable of withstanding the following wind loads in accordance with the IBC and ASTM E1300:
 1. Wind Load: As indicated on Structural Drawings.
- C. Windborne-Debris-Impact Resistance: Exterior glazed decorative metal railings passing ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [1] [2] [3] [4] for [basic] [enhanced] protection.
 1. Large-Missile Test: For exterior glazing located within 30 feet of grade.

2. Small-Missile Test: For exterior glazing located between 30 feet and [60 feet] <Insert dimension> above grade.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: [120 deg F, ambient; 180 deg F, material surfaces] <Insert temperature change>.

2.2 GLAZED DECORATIVE METAL RAILINGS

- 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. C.R. Laurence Co., Inc.
 2. Viewrail
 3. FHC
 4. R & B Wagner, Inc.
 5. Or Equal.
- B. Source Limitations for Laminated Glass: Obtain from single source from single manufacturer.
- C. Source Limitations for Decorative Metal Railing Components: Obtain from single source from single manufacturer for each component and installation method.
- D. Product Options: Information on Drawings and in the Specifications establishes requirements for railing system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

2.3 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.4 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
- B. Extruded Bars and Shapes, Including Extruded Tube: ASTM B221, Alloy 6063-T5/T52.
- C. Extruded Structural Pipe and Round Tube: ASTM B429/B429M, Alloy 6063-T6.
 1. Provide Standard Weight pipe unless otherwise indicated.
- D. Drawn Seamless Tubing: ASTM B210, Alloy 6063-T832.
- E. Plate and Sheet: ASTM B209, [Alloy 5005-H32] [Alloy 6061-T6].
- F. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.
- G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.5 STAINLESS STEEL

- A. Tubing: ASTM A554, [Grade MT 304] [Grade MT 316].
- B. Pipe: ASTM A312/A312M, [Grade TP 304] [Grade TP 316].
- C. Castings: ASTM A743/A743M, [Grade CF 8 or Grade CF 20] [Grade CF 8M or Grade CF 3M].
- D. Sheet, Strip, Plate, and Flat Bar: ASTM A666 or ASTM A240/A240M, [Type 304] [Type 316].
- E. Bars and Shapes: ASTM A276, [Type 304] [Type 316].

2.6 STEEL AND IRON

- A. Tubing: [ASTM A500/A500M (cold formed)] [or] [ASTM A513/A513M].
- B. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

2.7 GLASS AND GLAZING PRODUCTS, GENERAL

- A. Glazing Publications: Comply with written instructions of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA/GANA Publications: ["GANA Laminated Glazing Reference Manual" and]"GANA Glazing Manual."
- B. Safety Glazing: Glazing is to comply with 16 CFR 1201, Category II.
- C. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label is to indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- D. Low-Iron Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.
- E. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Class 1 and low-iron clear, or Class 2 (tinted) as indicated, Quality-Q3.
- F. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- G. Ceramic-Coated Glass: Heat-strengthened float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual" and with other requirements specified.
- H. Bent Glass: ASTM C1464, [Kind BFT (bent, tempered)] [Kind BHS, (bent, heat strengthened)] [Kind BL, (bent, laminated)].
- I. Glazing Cement and Accessories for Structural Glass Railings: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.
- J. Sealant and Accessories for Structural Glass Railings: Sealant, gaskets, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.
- K. Glazing Gaskets for Glass-Infill Panels: Glazing gaskets and related accessories as recommended or supplied by railing manufacturer for installing glass-infill panels in post-supported railings.

2.8 GLASS HANDRAILS AND GUARDS

- A. Tempered Glass Handrails and Guards: Provide products that have been tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.
 - 1. Glass Color: [Clear] [Blue] [Blue-green] [Bronze] [Green] [Gray] <Insert color>.
 - 2. Thickness for Structural Glass Balusters: As required by structural loads, but not less than [12.0] [19.0] mm.
 - 3. Thickness for Glass-Infill Panels: As required by structural loads, but not less than [12.0] mm.
 - 4. Glass Thickness: As indicated on Drawings.
- B. Laminated Glass Handrails and Guards: ASTM C1172, Type II with two plies of glass bonded together by an interlayer.
 - 1. Construction: Laminate glass with [polyvinyl butyral interlayer] [or] [ionoplast polymer interlayer] to comply with interlayer manufacturer's written instructions.
 - 2. Interlayer Thickness: [0.030 inch] [0.060 inch] [0.090 inch].
 - 3. Kind: [LHS (laminated heat strengthened)] [LT (laminated tempered)] [As indicated].
 - 4. Glass Color: Inner-ply [clear] [low-iron clear] [blue] [blue-green] [bronze] [green] [gray] <Insert color>; outer-ply [clear] [low-iron clear] [blue] [blue-green] [bronze] [green] [gray] <Insert color>.
 - 5. Ceramic Coating Color and Pattern: [As selected by Architect from manufacturer's full range] <Insert manufacturer's color and pattern designation>, applied to [inner] [outer] glass ply.
 - 6. Interlayer Color: [Clear] [Blue-green] [Bronze light] [Gray] <Insert color>.
 - 7. Interlayer Color and Pattern: [As selected by Architect from manufacturer's full range] [Match] [Provide] <Insert manufacturer's color and pattern designation>.
 - 8. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than [6.0] [8.0] mm thick each.
 - 9. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than [6.0] mm each.

2.9 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 - 1. Aluminum Components: [Type 304] [Type 316] stainless steel fasteners.
 - 2. Stainless Steel Components: [Type 304] [Type 316] stainless steel fasteners.
 - 3. Dissimilar Metals: [Type 304] [Type 316] stainless steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated [and capable of withstanding design loads].
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless exposed fasteners are unavoidable.
 - 1. Provide [tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated].
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 for mechanical anchors or ICC-ES AC308 for adhesive anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.

2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [Group 1] [Group 2] stainless steel bolts, ASTM F593, and nuts; ASTM F594.

2.10 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: [Cast aluminum,] [Cast stainless steel,] [Cast bronze,] [Cast brass,] [Cast copper,] [Cast nickel-silver,] center of rail [2-1/2 inches] [3-1/8 inches] <Insert dimension> from face of structural glass balusters.
- B. Wood Rails:
 1. Clear, straight-grained hardwood rails secured to [recessed] [exposed] metal sub rail.
 - a. Species: [Ash] [Cherry] [Red oak] [Walnut] [White oak] <Insert species>.
 - b. Finish: [Manufacturer's standard] [Transparent polyurethane] [Penetrating oil] [Acrylic impregnated].
 - c. Staining: [None] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert description or manufacturer's name and product designation>.
 - d. Profile: [Square, 1-3/4 by 1-3/4 inches with edges eased to 1/4-inch radius] [Rectangular, 1-3/4 by 5 inches with edges eased to 1/4-inch radius] [Round, 2-inch diameter] [As indicated] <Insert description>.
 2. Hardwood rails complying with Section 064023 "Interior Architectural Woodwork."
 3. Certified Wood: Wood products shall be certified as "FSC Pure"[or "FSC Mixed Credit"] according to FSC STD-01-001 and FSC STD-40-004.
- C. Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Non-shrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- F. Anchoring Cement: Factory-packaged, non-shrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 1. Water-Resistant Anchoring Cement: [At exterior locations] [and] [where indicated] provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.11 FABRICATION OF METAL RAILINGS

- A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage [, but not less than that required to support structural loads].
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.

- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- H. Form changes in direction as follows:
 - 1. As detailed.
 - 2. By bending to smallest radius that will not result in distortion of railing member.
- I. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- J. Close exposed ends of hollow railing members with prefabricated end fittings.
- K. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, miscellaneous fittings, and anchors to interconnect railing members to other work where indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.
- L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- M. For railing posts set in concrete, provide [steel] [stainless steel] sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

2.12 FABRICATION OF GLASS PANELS AND BALUSTERS

- A. Fabricate glass to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
- B. Glass-Infill Panels: Provide [tempered] [laminated, heat-strengthened] [laminated, tempered] glass-infill panels [for both straight and curved sections].
 - 1. Edge Finish: [Clean-cut or flat-grind edges to produce smooth, square edges with slight chamfers at junctions of edges and faces] <Insert edge finishes>.
- C. Structural Glass Balusters: Provide [tempered] [laminated, heat-strengthened] [laminated, tempered] structural glass balusters [for both straight and curved sections].
 - 1. Edge Finish: [Grind smooth and flat polish exposed edges of glass, including those at open joints, to produce smooth, square edges with glass edge finishes].
 - 2. Factory-bond structural glass balusters to aluminum base and top-rail channels in railing manufacturer's plant using [glazing cement] [sealant] to comply with manufacturer's written instructions [, unless field glazing is standard with manufacturer].
 - 3. Fabricate structural glass balusters to maintain equal length glass widths and uniform spacing of [1/2 inch] <Insert spacing> between glass balusters.

2.13 METAL FINISH REQUIREMENTS, GENERAL

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.14 ALUMINUM FINISHES

- A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.
- B. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
- C. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
 - 1. Color: [Champagne] [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
- D. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [AAMA 2604] [AAMA 2605] and containing not less than [50] [70] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 - 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- E. Superior-Performing Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 - 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- F. Superior-Performing Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 - 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

- G. Superior-Performing Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- H. Superior-Performing Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
 - 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

2.15 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Stainless Steel Tubing Finishes:
 - 1. 180-Grit Polished Finish: Uniform, directionally textured finish.
 - 2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
 - 3. Polished and Buffed Finish: 320-grit finish followed by buffing [to a high luster finish] [to a mirrorlike finish] [to match Architect's sample].
- D. Stainless Steel Sheet, Strip, Plate, and Bar Finishes:
 - 1. Directional Satin Finish: ASTM A480/A480M, No. 4.
 - 2. High Luster Finish: ASTM A480/A480M, No. 7.
 - 3. Mirror Finish: ASTM A480/A480M, No. 8.

PART 3 - EXECUTION – NOT USED

END OF SECTION 057313

SECTION 061600 - SHEATHING

GUIDELINES

1. *Manage delivery, storage and installation to comply with manufacturers exposure limits.*
2. *Coordinate sheathing system with required fire ratings and NFPA 285 requirements.*
3. *Coordinate with selected exterior wall envelope air / weather barrier system, including rainscreen systems.*
4. *Confirm gypsum sheathing used at parapet conditions complies with fire resistance rating.*
5. *Where used as a substrate for roof membranes, verify type and finish per manufacturer approval.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Exterior gypsum sheathing at plaster wall assemblies.
 2. Exterior gypsum sheathing at metal wall panels.
 3. Exterior gypsum sheathing at parapet wall assemblies.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Formaldehyde Emissions: Contains no added urea formaldehyde.
- B. Fire-Resistance Ratings: As tested in accordance with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 GYPSUM PARAPET WALL SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
 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. Georgia-Pacific Gypsum LLC.
 - b. Or Equal.
 2. Type and Thickness: Type X, 5/8 inch thick.
- B. Series: DensDeck Prime

2.3 GYPSUM WALL SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
 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. Georgia-Pacific Gypsum LLC.
 2. Type and Thickness: Type X, 5/8 inch thick.
- B. Series: Densglass Fireguard

SHEATHING

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2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For sheathing, provide fasteners **[with hot-dip zinc coating complying with ASTM A153/A153M] [of Type 304 stainless steel]**.
 - 2. For sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: NES NER-272. Fastener systems with an evaluation report acceptable to DSA, based on ICC-ES AC70.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.
- F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B 117.
 - 1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
 - 2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

2.5 MISCELLANEOUS MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Provide minimum 20 gage galvanized steel backing for all plaster accessories, roofing termination bars, and other products anchored at sheathing surface.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

GUIDELINES

1. *Standard is based on North American Architectural Wood Standard (NAAWS) published by Woodwork Institute (WI). This section is written to cover a range of applications, including hardware and finish, for selection based on the design and District user criteria. Familiarity with the NAAWS is assumed.*
2. *Consider requiring WI Certified Compliance Program (CCP) for woodwork.*
3. *In order to establish desired quality level, materials and fabrication exceed WI NAAWS specified Custom grade requirements in some cases.*
4. *Consider requiring special procedures for temperature and relative humidity control procedures and systems as required to protect and properly install paneling and millwork, based on specific site location, microclimate conditions, time of year, temperature and relative humidity of specific area. Adjust procedures as required to reflect changed environmental conditions.*
5. *District preferred wood species is maple as specified. Review options with District as required by Design. Coordinate species with wall paneling and lab casework.*
6. *The term "Well Matched", taken from NAAWS, is used to reduce grain and color variation between wood veneer elements. For the purposes of this section, it means members that make up the components of an assembly and components of an adjacent assembly are similar and nearly uniform in color and have similar grain, figure and character. Adjacent members shall be the same grain type.*
7. *Banquette (Bench) seating requires coordination with District and vendors regarding seaming, foam type and density. Example specified.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes interior architectural woodwork items including, but not limited to, the following:
1. Architectural wood cabinets - Transparent Finish: Type 1.
 2. Architectural wood cabinets - Opaque Finish: Type 2.
 3. Plastic-laminate-faced architectural cabinets - Type 3.
 4. Banquette seating assemblies.
 5. Interior ornamental woodwork.
 6. Solid surfacing fabrications.
 7. Interior standing and running trim for transparent finish.
 8. Interior standing and running trim for opaque finish.
 9. Preservative-treated wood material.
 10. Fire-retardant-treated wood material.
 11. Miscellaneous materials.
 12. Shop priming.
 13. Shop finishing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Meet with Owner to identify locking requirements for all casework, including lock type, cylinder, and keying provisions for each casework type and application. Provide as separate submittal.

B. Banquette Cushions

1. Comply with seating requirements per California Technical Bulletin 117 - Requirements, Test Procedure and Apparatus for Testing the Flame Retardance of Resilient Filling Materials used in Upholstered Furniture.
 - a. Comply with the applicable requirements of the State of California Technical Bulletin (TB) 117-13, latest issue for upholstery components (fabrics, vinyl, leathers, foams, batting, etc.) used in seating products. Comply based on testing and periodic retesting of the upholstery components by the component or seating manufacturer or an independent laboratory.
 - b. Submit evidence of compliance with TB 117-13.
 - 1) Product sample cards indicating compliance of the described upholstery components with TB 117-13;
 - 2) Component manufacturers' published product specification sheets indicating compliance of the described upholstery components with TB 117-13;
 - 3) Published commercial catalogs (from component supplier or furniture manufacturer) indicating compliance of specifically identified upholstery components, such as a listing of fabric pattern names, with TB 117-13. Statements of compliance addressing general categories of components, such as "all our fabrics and filling materials meet TB 117", are NOT acceptable.;
 - 4) Laboratory test reports showing that the tested upholstery components meet all applicable sections of TB 117-13. In order to be considered complete and acceptable, a test report must include: specific identification of the tested product; the individual specimen results; the test date (not more than 3 years old when submitted); and the name of the testing entity and signed by the engineer responsible for flammability compliance.

C. Structural Performance for cantilevered countertops:

1. Loading Criteria:
 - a. 300 lb. vertical gravity loading applied over an area 18 inch by 18-inch square at any part of the casework horizontal surface to create maximum stress and deflection condition.
2. Performance Deflection Criteria:
 - a. No greater than 1 /8-inch vertical deflection perpendicular to the horizontal plane of the casework as noted in loading criteria.
3. Connection Criteria:
 - a. Provide calculations for all embeds and backing required to accommodate cantilever casework frame.

2.2 ARCHITECTURAL WOODWORK, GENERAL

- A. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of architectural wood cabinets with sequence-matched wood veneers.
- B. Quality Standard: Unless otherwise indicated, comply with the "North American Architectural Woodwork Standard" (NAAWS) jointly published by WI and AWMAC for grades of architectural woodwork indicated for construction, finishes, installation, and other requirements.
 1. Provide labels and certificates from WI certification program indicating that woodwork, including installation, complies with requirements of grades specified.

2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

2.3 WOOD CABINETS FOR TRANSPARENT FINISH - TYPE 1

- A. Grade: Custom.
- B. Type of Construction: Frameless.
 1. Glue Bond: Type II (interior).
 2. Glue and Core: Urea Formaldehyde free.
 3. Finish: AWS System - 12, water-based polyurethane, matte sheen, clear.
 4. Construction: MDF core, Fire Retardant as specified.
- C. Cabinet and Door and Drawer Front Interface Style: Flush overlay.
- D. Reveal Dimension: [1/2 inch] [as indicated].
- E. Definition of Exposed: In addition to NAAWS definition, for purposes of this specification, Exposed surfaces include:
 1. Visible surfaces of open cabinets.
 2. Both sides of all adjustable shelves.
 3. Both sides of door panels.
- F. Exposed Surfaces: Wood
 1. Species: Hard White Maple.
 2. HPVA HP-1 Grade: AA.
 3. Cut: [Rotary/Flat] [Quarter].
 4. Grain Direction: As selected by District based on species, grain cut and design.
 5. Matching of Veneer Leaves: Book match.
 6. Veneer Matching within Panel Face: Center-balance match.
 7. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.
 8. Color and grain selection: Well matched.
 9. Backing Veneer Species: Any hardwood compatible with face species.
 10. Case, Door and Drawer Panel Edge: Solid hardwood edge, species to match veneer and as shown on drawings.
- G. Semi-Exposed Surfaces: Provide surface materials indicated below:
 1. Surfaces Other Than Drawer Bodies:
 - a. Thermoset decorative panels.
 - b. Edges of adjustable Shelves: PVC or polyester edge banding, 3 mm thickness, color and pattern as selected by Architect.
 2. Drawer Sub fronts, Backs, and Sides:
 - a. Solid-hard wood lumber.
 - b. Thermoset decorative panels with PVC or polyester edge banding, 1 mm thickness.
 3. Drawer Bottoms: Hardwood plywood.
- H. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.

- I. Drawer Construction: Fabricate with exposed fronts fastened to sub front with mounting screws from interior of body.
 1. Join sub fronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

2.4 THERMOSET FINISHED SHEET MATERIAL

- A. Thermoset (Thermo-fused Laminate (TFL) Finish: Melamine resin impregnated paper, thermally fused to substrate.
 1. Substrate Core: As specified.
 2. Paper Core Density: 85 gram/square meter.
 3. Performance Characteristics:
 - a. Surface Burning Characteristics: Class C per ASTM E 84. Class A available based on UL approved substrate and adhesive.
 - b. Wear Resistance: 700-900 cycles solid colors, 200 cycles patterns/woods, per NEMA LD3 3.13
 - c. Boiling Water Resistance: No effect, dark colors may show slight effect per NEMA LD-3, 3.5
 - d. High Temperature Resistance: Slight effect per NEMA LD-3, 3.6
 - e. Radiant Heat Resistance: No effect after 80 seconds of exposure on solid colors, No effect after 80 seconds of exposure patterns/woods, per NEMA LD-3, 3.10
 - f. Stain Resistance to NEMA 3.4: No effect 1-10; no effect to slight effect 11-15.
 - g. Cleanability of Surface: 10. 9, per NEMA LD-3, 3.4.
 - h. Light Resistance: No effect to slight effect, per NEMA LD-3, 3.3.
 4. Finish: Satin.
 5. Color: As selected by Architect.

2.5 WOOD CABINETS FOR OPAQUE FINISH - TYPE 2

- A. Grade: Custom.
- B. Type of Construction: Frameless.
 1. Glue and Core: Urea Formaldehyde free.
 2. Finish: AWS System - 12, water-based polyurethane, matte sheen, clear.
 3. Provide security fasteners at cabinets as specified in Section 018853.
 4. Construction: MDF core, Fire Retardant as specified.
- C. Cabinet and Door and Drawer Front Interface Style: Flush overlay.
- D. Reveal Dimension: [1/2 inch][As Indicated].
- E. Species for Exposed Lumber Surfaces: Any closed-grain hardwood, suitable for matching finish.
- F. Panel Product for Exposed Surfaces: Medium-density fiberboard.
- G. Semi-Exposed Surfaces: Provide surface materials indicated below:
 1. Surfaces Other Than Drawer Bodies:
 - a. Match materials indicated for exposed surfaces
 - b. Thermoset decorative panels.
 - c. Edges of adjustable Shelves: PVC or polyester edge banding, 3 mm thickness, color, pattern, and finish as selected by Architect.
 2. Thermoset (Melamine) are acceptable at vertical interior surfaces of casework interiors, including division panels, backs and the lower face of cabinet tops.

3. Drawer Sides and Backs:
 - a. Solid-hard wood lumber.
 - b. Thermoset decorative panels with PVC or polyester edge banding.
 4. Drawer Bottoms: Hardwood plywood.
 - H. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
 - I. Drawer Construction: Fabricate with exposed fronts fastened to sub front with mounting screws from interior of body.
 1. Join sub fronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.
- 2.6 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS - TYPE 3
- A. Grade: Custom.
 - B. Type of Construction: Frameless.
 1. Glue Bond: Type II (interior).
 2. Glue and Core: Urea Formaldehyde free.
 3. Provide security fasteners at cabinets as specified in Section 018853.
 4. Construction: MDF core, Fire Retardant as specified.
 - C. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.
 - D. Reveal Dimension: [1/2 inch][as indicated].
 - E. Definition of Exposed: In addition to NAAWS definition, for purposes of this specification, Exposed surfaces include:
 1. Visible surfaces of open cabinets,
 2. Both sides of all adjustable shelves.
 3. Both sides of door panels.
 - F. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.
 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. Abet Laminati, Inc.
 - b. Formica Corporation.
 - c. Wilsonart International Holdings, Inc.
 - G. Exposed Surface: Laminate Cladding
 1. Horizontal Surfaces: Grade HGS.
 2. Postformed Surfaces: Grade HGP.
 3. Vertical Surfaces: [Grade HGS] [Grade VGS.]
 4. Edges: PVC edge banding, 3 mm thick, matching laminate in color, pattern, and finish.
 5. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels. Provide full laminated plastic panel surface at all cases, doors and drawer faces.
 - a. Obtain approval of seam location at fascias, soffits and bases.
 - H. Materials for Semi-Exposed Surfaces:
 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.

- a. Edges of Plastic-Laminate Shelves: PVC edge banding, 3 mm thick, matching laminate in color, pattern, and finish.
2. Thermoset (Melamine) are acceptable at vertical interior surfaces of casework interiors, including division panels, backs and the lower face of cabinet tops.
3. Drawer Sides and Backs:
 - a. Solid-hard wood lumber.
 - b. Thermoset decorative panels with PVC or polyester edge banding.
4. Drawer Bottoms: Hardwood plywood.
- I. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- J. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- K. Drawer Construction: Fabricate with exposed fronts fastened to sub front with mounting screws from interior of body.
 1. Join sub fronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.
- L. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 1. As selected by Architect from laminate manufacturer's full range in the following categories:
 - a. Solid colors, matte finish.
 - b. Solid colors with core same color as surface, matte finish.
 - c. Wood grains, matte finish.
 - d. Patterns, matte finish.

2.7 BANQUETTE SEATING ASSEMBLIES

- A. Provide banquette seating assemblies as shown on Drawings complying with following requirements.
- B. Construction:
 1. Frames: Solid hardwood upright frames; triple dowelled legs.
- C. Seat Upholstery Fabric :
 1. Manufacturer and Series: As indicated on Drawings or equal.
 2. Fire/Life Safety/Habitability Characteristics:
 - a. Flame Spread Index: Maximum 25 per ASTM e 84.
 - b. Smoke Developed Index: Maximum 100 per ASTM E 84.
 - c. Compliant with California Technical Bulletin TB 117.
 3. Finish/Colors, Textures, and Patterns: As indicated on Drawings.
- D. Foam Cushion and Backing:
 1. Resiliency: HR
 2. Density: 2.8.
 3. ILD: 33
 4. Hybrid foam: Containing minimum 25 percent non-petroleum based Polyols, derived from a renewable resource such as soy.
 5. Cushion Wrap: Provide Dacron or approved equal cushion wraps, book wrapped, laminated to foam.

- E. Fire/Life Safety/Habitability Characteristics:
 - 1. Flame Spread Index: Maximum 25 per ASTM E 84.
 - 2. Smoke Developed Index: Maximum 100 per ASTM E 84.
 - 3. Formulate foams to comply with California Technical Bulletin TB 117.
 - 4. Comply with ASTM D 3574.
- F. Seat cushion construction.
 - 1. Seams shall be double stitched, flat, without piping edge.
 - 2. Provide concealed zipper edge permitting removal of fabric cover from cushion.
 - 3. Provide two full length Hook and Loop/Velcro strips, each 2-inch wide, at each cushion for anchorage, self-adhered to both sides.
- G. Design:
 - 1. Removable upholstered seats and backs; locking cleat.
 - 2. Full upholstered seats with upholstered sides.
 - 3. Laminate-faced back partition with vertical channel back upholstered back cushion insert.
 - 4. Laminate-faced crumb channel.
 - 5. Recessed base; brushed stainless steel finish.

2.8 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

- A. Grade: Custom.
- B. Wood Species and Cut: Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated, well matched for grain and color.
 - 1. Species: White oak.
 - 2. Cut: Rift cut/rift sawn.
 - 3. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.
- C. For trim items other than base wider than available lumber, use veneered construction. Do not glue for width.
 - 1. For veneered base, use hardwood lumber core, glued for width.
- D. For base wider than available lumber, glue for width. Do not use veneered construction.
- E. For rails thicker than available lumber, use veneered construction. Do not glue for thickness.

2.9 INTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH

- A. Grade: Custom.
- B. Wood Species: Any closed-grain hardwood.

2.10 SHEET MATERIALS

- A. Composite Wood Products: Provide materials that comply with requirements of the Architectural Woodwork Standards for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.
 - 1. Recycled Content of MDF and Particleboard: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than **<Insert value>** percent.
 - 2. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130, 47-pound density minimum.
 - 3. Ultra-Light Density Fiberboard: Industrial Grade Medium Density Fiberboard (MDF), manufactured with a formaldehyde-free adhesive system and which meets the physical properties of ANSI A208.2-2016, 31-pound density minimum

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4. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue ANSI A208.2, Industrial M3 Grade, mat-formed flat panel consisting of particles of wood bonded together with a synthetic formaldehyde-free (NAF) adhesive system, 45 -pound density minimum.
5. Softwood Plywood: DOC PS 1, medium-density overlay.
6. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.11 PRESERVATIVE-TREATED-WOOD MATERIAL

- A. Preservative-Treated-Wood Materials: Provide with water-repellent preservative treatment complying with AWWPA N1 (dip, spray, flood, or vacuum-pressure treatment).
 1. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.
 2. Select treatment method with Greenguard listing and "red-list" free listing.
- B. Extent of Preservative-Treated Wood Materials: Treat interior architectural woodwork in contact with concrete or masonry.

2.12 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to DSAHCAI and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
 1. Use treated materials that comply with requirements of referenced woodworking standard. Do not use materials that are warped, discolored, or otherwise defective.
 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
 4. Select treatment method with Greenguard listing and "red-list" free listing.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 4. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
- C. Fire-Retardant Fiberboard: Medium-density fiberboard (MDF) panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture, to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less in accordance with ASTM E84.

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. Roseburg.

2.13 CABINET HARDWARE AND ACCESSORIES

- A. Hardware Standard: Comply with NAAWS Section 10 requirements for ANSI/ BHMA Grade 2, unless otherwise specified.
- B. Butt Hinge [Type 1] [Type 2] [Type 3] Cabinet:
 1. Rockford Process or equal, RPC 5 knuckle overlay hinges, hospital tip, size as required by casework condition. Finish as selected by Architect.
 2. Frameless Concealed Hinges (European Type) - [Type 1] [Type 2] [Type 3] Cabinets: BHMA A156.9, B01602, [89] [120] [170] degrees of opening, self-closing; equivalent to following:
 3. Blum No. 71 6580 with Plate 173H9100.
 4. Grass No. 3903VZ with mounting plate 10761.
 5. Hafele No. 329.07.654 with plate.
- C. Continuous Hinge One Monroe or equal, heavy duty, continuous hinge, predrilled fasteners, concealed mounting, stainless steel.
- D. Exposed Barrel Hinge: Recessed Cup, 180-degree to 270-degree swing, with height and lateral adjustment, complying with BHMA A 156.9, nickel finish.
 1. Hafele: Aximat 3000 Hinge.
- E. Flush Pull: [Type 1][Type 2] Cabinet: Assa Abloy Rockwood or equal 94C Flush Pull, stainless steel, mechanically fastened, vertical orientation.
- F. Wire Pulls [Type 1] [Type 2] Cabinet: Back mounted, BHMA A156.9, B02011 solid brass, 4 inches long, 5/16 inch in diameter; equivalent to the following:
 1. No. 4484 by Stanley Hardware.
 2. No. MC-4024 by Epco Hardware.
 3. No. 6208 by National Lock and Cabinet Hardware.
 4. Sugatsune/Lamp or equal, DL150, 5-inch centers, stainless steel with brushed stainless-steel finish.
- G. Catches: Magnetic catches, BHMA A156.9, B03141, Grade 1, with clear anodized aluminum case and impregnated floating rubber magnet, zinc plated strike, slotted screw holes in case and off-center hole in strike, equivalent to No. SP41 or SP45 by Stanley Hardware, or approved equal.
- H. Shelf Rests: Unless otherwise indicated, provide Hafele 282.11.752, nickel finish, with screw hole on bearing surface.
- I. Counter Support Brackets:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide "Rakks Counter Support Bracket, EH Inside wall series, by the Rangine Corporation or acceptable comparable product.
 2. Configuration: Surface mounted. Flush mounted.
 3. Material: ASTM B221, 6063 T5, horizontal T-shape and vertical L-shape extruded aluminum bracket with MIG welding across 45-degree miters and back.
 4. Load Capacity: 450 pounds per bracket minimum.

5. Faceplates: 4-inch by 4-inch aluminum faceplates with adhesive backing, notched to fit around vertical flange of flush mounted counter support bracket, to conceal penetration through gypsum board.
 6. Finish: Custom powder coat finish as selected by Architect from manufacturer's full range.
- J. Drawer Slides: BHMA A156.9, B05111; Side-mounted, full-extension, all ball bearing zinc-plated steel drawer slides with hold-in detent, rated for indicated loads, and equivalent to the following:
1. Drawers 6-inches or less in depth and up to 16-inches in width:
 - a. Model 3832SC, 100 lb./pr. load rating, telescoping, self-closing movement, by Accuride International, or approved equal.
 2. Drawers 6-inches or less in depth and up to 24-inches in width:
 - a. Model 7432, 100 lb./pr. load rating, progressive movement, by Accuride International, or approved equal.
 3. Drawers over 6-inches in depth and up to 42-inches in width:
 - a. Model 3640, 200lb./pr. load rating, sequential movement, by Accuride International, or approved equal.
- K. Door and Drawer Locks:
1. BHMA A156.11, E07121. Provide lock type, keying and locking requirements for all casework, including keying provisions for each casework type and application as directed by Owner.
 - a. Meet with Owner to identify locking requirements for all casework, including lock type, cylinder, and keying provisions for each casework type and application.
 2. Door and Drawer Locks: Multi-function pin tumbler cam locks suitable for specific project applications. All brass construction with 26D-Dull Chrome finish. Provide two stamped brass keys per lock. Locks to be capable of 850 key changes.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide Hafele/National Lock Co.; No. C8053 or comparable product as approved by Architect for full overlay doors.
 3. All locks shall be keyed alike within each room and master keyed, including locks on under-counter refrigerators. Locks on inner and outer doors of narcotics cabinets shall be keyed separately.
- L. Wardrobe Curtain Rods and Supports:
1. TYPE 1: Hafele or equal, Synergy round rail, 801.42.200, with metal socket supports.
 2. Hook: Hafele or equal, 980.85.450
- M. Door and Drawer Silencers: BHMA A156.16, L03011.
- N. Grommets for Cable Passage through Countertops: 2-inchOD, black, white, molded-plastic grommets and matching plastic caps with slot for wire passage.
1. SG series" by Doug Mockett and Co., Inc. or equal.
 2. "LO3" set by Doug Mockett and Co., Inc., Richelieu, or equal
- O. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q3, with exposed edges seamed before tempering, 6 mm thick unless otherwise indicated.
- P. Tempered Float Glass for Cabinet Shelves: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q3; with exposed edges seamed before tempering, 6 mm thick.

- Q. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - 1. Satin Stainless Steel: BHMA 630.
- R. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.14 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
 - 1. Preservative Treatment: Provide softwood lumber treated by pressure process, AWPA U1; Use Category UC3b.
 - a. Provide where in contact with concrete or masonry.
 - b. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
 - c. Preservative Chemicals: Acceptable to DSAHCAI.
 - d. Mark lumber with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee's (ALSC) Board of Review.
 - 2. Fire-Retardant Treatment: Complying with requirements; provide where indicated.
- B. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.
 - 1. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
 - 2. Use nonferrous metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- D. Provide ProDec or equal snap-on caps matching plastic laminate color at round head or other fastener types when raised above exposed material surface and anchoring casework to wall framing.
- E. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.
- F. Stainless Steel Plate: ASTM A666, Type 304; thickness as shown on Drawings.

2.15 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate woodwork to dimensions, profiles, and details indicated.
 - 1. Ease edges to radius indicated for the following:
 - a. Corners of Cabinets and Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
 - b. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/8 inch.
- C. Fabricate in compliance with NAAWS Section 10 tolerances.
- D. Ornamental Woodwork: Fabricate ornamental woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Edges of Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
 - 2. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/8 inch.

- E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect 7 days in advance of the dates and times woodwork fabrication will be complete.
 - 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
 - 3. Fabricate all stand-alone end panels as two panels, minimum 1-1/2-inch-thick, with exposed finish on both sides. Anchor to floor with concealed clip.
 - 4. Exposed finish at all knee spaces and end panels shall extend to floor, extending past base frame.
- F. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of openings in countertops with a coat of varnish.
- G. Install glass to comply with applicable requirements in Section 088000 "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

2.16 SHOP PRIMING

- A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
- B. Interior Architectural Woodwork for Opaque Finish: Shop prime with one coat of wood primer as specified in Section 099123 "Interior Painting."
 - 1. Back priming: Apply one coat of primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.
- C. Interior Architectural Woodwork for Transparent Finish: Shop-seal concealed surfaces with required pretreatments and first coat of finish as specified in Section 099300 "Staining and Transparent Finishing."
 - 1. Back priming: Apply one coat of sealer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.

2.17 SHOP FINISHING

- A. Finish interior architectural woodwork with transparent finish at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural wood cabinets, as applicable to each unit of work.
 - 1. Back priming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of cabinets.

C. Transparent Finish:

1. Grade: Custom.
2. Finish System:
 - a. 1: Lacquer, Nitrocellulose.
 - b. 2: Lacquer, Pre Catalyzed.
 - c. 3: Lacquer, Post Catalyzed.
 - d. 4: Latex Acrylic, Water Based.
 - e. 5: Varnish, Conversion.
 - f. 6: Oil, Synthetic Penetrating.
 - g. Finish: System - 7, catalyzed vinyl.
 - h. 8: Acrylic Cross Linking, Water Based.
 - i. 9: UV Curable, Acrylated Epoxy, Polyester, or Urethane.
 - j. 10: UV Curable, Water Based.
 - k. 11: Polyurethane, Catalyzed.
 - l. 12: Polyurethane, Water Based.
 - m. 13: Polyester, Catalyzed.
3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to cabinets made from closed-grain wood before staining and finishing.
4. Staining: Match Architect's sample.
5. Open Finish for Open-Grain Woods: [Do not] apply filler to open-grain woods.
6. Filled Finish for Open-Grain Woods: After staining, apply wash-coat sealer and allow to dry. Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
7. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.
8. Sheen: Match Architect's sample.

D. Opaque Finish:

1. Grade: Custom.
2. Finish System:
 - a. 1: Lacquer, Nitrocellulose.
 - b. 2: Lacquer, Pre Catalyzed.
 - c. 3: Lacquer, Post Catalyzed.
 - d. 4: Latex Acrylic, Water Based.
 - e. 5: Varnish, Conversion.
 - f. 7: Vinyl, Catalyzed.
 - g. 8: Acrylic Cross Linking, Water Based.
 - h. 9: UV Curable, Acrylated Epoxy, Polyester, or Urethane.
 - i. 10: UV Curable, Water Based.
 - j. 11: Polyurethane, Catalyzed.
 - k. 12: Polyurethane, Water Based.
 - l. 13: Polyester, Catalyzed.
3. Color: As selected by Architect from manufacturer's full range.
4. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION - NOT USED

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SECTION 064216 - FLUSH WOOD PANELING

GUIDELINES

1. Evaluate FSC criteria for project conditions.
2. The term "Well Matched", taken from NAAWS, is used to reduce grain and color variation between paneling. For the purposes of this section, it means members that make up the components of an assembly and components of an adjacent assembly are similar and nearly uniform in color and have similar grain, figure and character. Adjacent panels and members shall be the same grain type.
3. Verify anchorage approach to provide seismic anchorage.
4. Verify material and installation comply with CBC Chapter 8, including furring.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Flush wood paneling
 2. Interior Finish Carpentry Trim
 3. Fire-retardant-treated materials.
 4. Installation materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements for the following:
1. Recycled content.
 2. Adhesives: VOC content and VOC emissions evaluation.
 3. Regional materials.
- B. Structural Requirements: Comply with DSA anchorage requirements, including clip or cleat restraint for seismic movement.
- C. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to AHJ. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.
- D. Paneling shall not exhibit failures including but not limited to:
1. Warping (bow, cup, or twist) of paneling components more than specified in referenced standard.
 2. Wood Veneer and trim delamination, splitting, blotching or discoloration.
 3. Failure of connections, supporting cleats, joint separation, telegraphing of fasteners or connections.
 4. Finish crazing, cracking or blotching.

2.2 SOURCE LIMITATIONS

- A. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of paneling and wood-veneer-faced architectural cabinets, wood trim, [and wood doors faced with veneers] from same flitches as paneling.
 - 1. Manufacturing/Fabrication Location: All woodwork, including woodwork panel components, shall be manufactured/fabricated within the continental United States or Canada.

2.3 PANELING, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of flush wood paneling (wood-veneer wall surfacing) indicated for construction, finishes, installation, and other requirements.
 - 1. Provide inspections of fabrication and installation together with labels and certificates from WI certification program indicating that woodwork complies with requirements of grades specified.
 - 2. The Contract Documents contain requirements that are more stringent than the referenced woodwork quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

2.4 FLUSH WOOD PANELING (WOOD-VENEER WALL SURFACING)

- A. Grade: Premium.
- B. Certified Wood: Wood products shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001 and FSC STD-40-004.
- C. Certified Wood: Wood products shall contain not less than 60 percent certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
- D. Wood Species and Cut: Hard White Maple, [rotary/flat] [quarter].
- E. Veneer Matching Method:
 - 1. Adjacent Veneer Leaves: Book match.
 - 2. Within Panel Face: Center-balance match.
 - 3. Adjacent Veneer Leaves and within Panel Face: [Slip][center-balance] [book match].
- F. Panel-Matching Method:
 - 1. [Adjacent panels shall be well matched for color and grain.] [No matching is required between adjacent panels. Select and arrange panels for similarity of grain pattern and color between adjacent panels.]
 - 2. Premanufactured panel sets used full width Premanufactured panel sets selectively reduced in width Made-to-order, sequence-matched panels Made-to-order, blueprint-matched panels and components within each separate area.
- G. Panel Core Construction: Hardwood veneer-core plywood.
 - 1. Thickness: 3/4 inch.
- H. Exposed Panel Edges: Inset solid-wood or wood-veneer matching faces.
- I. Panel Reveals: Matte black plastic laminate.

- J. Fire-Retardant-Treated Paneling: Panels are to consist of wood-veneer and fire-retardant particleboard or fire-retardant, medium-density fiberboard (MDF). Panels are to have a flame-spread index of 25 or less and a smoke-developed index of 450 or less per ASTM E84 and be listed and labeled by a testing and inspecting agency acceptable to DSA.
- K. Assemble panels by gluing and concealed fastening.

2.5 MATERIALS

- A. Materials, General: Provide materials that comply with requirements of referenced quality standard for each quality grade specified unless otherwise indicated.
- B. Wood Moisture Content: 8 to 13 percent.
- C. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each quality grade specified unless otherwise indicated.
 - 1. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:
 - a. MDF More Than 5/16 Inch Thick: 0.11 ppm.
 - 2. Composite Wood Products: Products shall be made without urea formaldehyde.
 - 3. MDF: ANSI A208.2, Grade 130.
 - 4. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.
- D. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.6 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to DSA and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
 - 1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
 - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 - 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 - 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 - 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 - 4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of paneling.

2.7 PANELING ANCHORS

- A. Manufacturer: Monarch Metal Fabrication or equal.
- B. Type: Interlocking galvanized [steel] aluminum] cleat system.
 - 1. Use of wood clips is not acceptable.
- C. Series: Provide dimension, and size as indicated with provisions for gravity and lateral restraint.
 - 1. Wall Series: <as required by loading and detailing>.
 - 2. Ceiling Series: <as required by loading and detailing>

2.8 INSTALLATION MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls.

2.9 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Arrange paneling in shop or other suitable space in proposed sequence for examination by Architect. Mark units with temporary sequence numbers to indicate position in proposed layout.
 - 1. Lay out one elevation at a time if approved by Architect.
 - 2. Notify Architect seven days in advance of the date and time when layout will be available for viewing.
 - 3. Provide lighting of similar type and level as that of final installation for viewing layout unless otherwise approved by Architect.
 - 4. Rearrange paneling as directed by Architect until layout is approved.
 - 5. Do not trim end units and other nonmodular-size units to less than modular size until after Architect's approval of layout. Indicate trimming by masking edges of units with non marking material.
 - 6. Obtain Architect's approval of layout before start of assembly. Mark units and Shop Drawings with assembly sequence numbers based on approved layout.
- C. Complete fabrication, including assembly, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times paneling fabrication will be complete.
- D. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burs.

2.10 SHOP FINISHING

- A. General: Finish paneling at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- B. Shop Priming: Shop apply the prime coat including back priming, if any, for transparent-finished paneling specified to be field finished..

- C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling counter-sunk fasteners, sealing concealed surfaces, and similar preparations for finishing paneling, as applicable to each unit of work.
 - 1. Back priming: Apply two coats of sealer or primer, compatible with finish coats, to concealed surfaces of paneling.
- D. Transparent Finish:
 - 1. Grade: Custom.
 - 2. Finish: System - 11, catalyzed polyurethane 12, water-based polyurethane.
 - 3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
 - 4. Staining: Match Architect's sample.
 - 5. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
 - 6. Filled Finish for Open-Grain Woods: After staining, apply wash-coat sealer and allow to dry. Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
 - 7. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D523.

PART 3 - EXECUTION - NOT USED

END OF SECTION 064216

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SECTION 066400 - PLASTIC PANELING

GUIDELINES

1. *Plastic paneling is typically referred to as FRP, and often used in janitors, back of house utility spaces and similar functions.*
2. *Provide Class A fire rated material.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Plastic sheet paneling.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain plastic paneling and trim accessories from single manufacturer.

2.2 PLASTIC SHEET PANELING

- A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D5319. Panels are to be USDA accepted for incidental food contact.
 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. Crane Composites, Inc.
 - b. Or equal
 2. Surface-Burning Characteristics: As follows when tested by a qualified testing agency in accordance with ASTM E84. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 3. Nominal Thickness: Not less than 0.075 inch 0.09 inch.
 4. Surface Finish: [Smooth] [Molded pebble] texture.
 5. Color: As selected by Architect from manufacturer's full range.

2.3 ACCESSORIES

- A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, **[outside corners,]** and caps as needed to conceal edges.
 1. Color: As selected by Architect from manufacturer's full range.
- B. Concealed Mounting Splines: Continuous, H-shaped aluminum extrusions designed to fit into grooves routed in edges of factory-laminated panels and to be fastened to substrate.
- C. Adhesive: As recommended by plastic paneling manufacturer.

- D. Sealant: Mildew-resistant, single-component, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 079200 "Joint Sealants."
 - 1. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 072313 - BELOW GRADE VAPOR BARRIER

GUIDELINE

1. Vapor Barrier is sometimes referred to as “Vapor Retarder” or “Vapor Diffusion Barrier”. Vapor Barrier is defined as having maximum permeance of 0.01 perms – Vapor retarders have higher perm values and allow more vapor to pass through.
2. Note this section does not cover below slab fuel, methane or radon membrane containment conditions.
3. Coordinate tie-in between below slab-on-grade membrane and pit membrane.
4. Pit membrane selected for placement on prepared grade and cut earth face. Provides blind side waterproofing/vapor retarder.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Below Grade Vapor Retarder at:
 - a. Slab-on grade
 - b. Elevator pit.

PART 2 - PRODUCTS

2.1 BELOW GRADE VAPOR BARRIER - SLAB ON GRADE

- A. Manufacturer:
1. StegoWrap (Basis of Design)
 2. Or Equal.
- B. Type: Multi-layer polyolefin sheet.
- C. Series.
1. STEGO WRAP 15 VAPOR BARRIER.
- D. Characteristics:
1. Thickness: 15 mil
 2. Classification: ASTM E 1745, Class A
 3. Tensile Strength, Membrane: 70 lb/ft/in; ASTM D 882.
 4. Puncture Resistance: 2,220 grams per ASTM D 1709
 5. Water Vapor Permeance after conditioning:
 - a. Soil Organism Exposure; 0.0095 perms per ASTM F1249
 - b. Wetting, Drying, soaking: 0.0098 perms per ASTM F1249
 - c. Heat Conditioning; 0.0091 perms per ASTM F1249.
- E. Accessories: Provide manufacturers recommended:
1. Premanufactured pipe boot sheet
 2. Seam and edge tape.

2.2 BELOW GRADE VAPOR BARRIER - ELEVATOR PIT

- A. Manufacturer:
1. GCP Applied Technologies (formerly known as Grace Construction Products) or equal.
- B. Type: Polyolefin sheet, minimum 46 -mil nominal thickness, self-adhering sheet formulated for application under liquid concrete or as blind side waterproofing.

- C. Series.
 - 1. Preprufe 300R Plus/300R LT.
- D. Characteristics:
 - 1. Tensile Strength, Membrane: 4000 psi; ASTM D 412.
 - 2. Ultimate Elongation: 500 percent minimum; ASTM D 412, Die C, modified.
 - 3. Puncture Resistance: 225 pounds per ASTM E 154.
 - 4. Water Vapor Permeance: 0.01 perms maximum; ASTM E 96/E 96M, Method B.
 - 5. Peel Adhesion to Concrete: Minimum 10 pounds/inch, after 3 years water immersion, per ASTM D903.

2.3 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
 - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid waterborne primer recommended for substrate by sheet-waterproofing material manufacturer.
- C. Liquid Membrane: Bituthene Liquid Membrane, Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.

PART 3 - EXECUTION NOT USED

END OF SECTION

SECTION 074213.13 - FORMED METAL WALL PANELS

GUIDELINES

1. *Specify additional or alternate design profile*
2. *Verify panel gage and attachment method based on structural performance requirements*
3. *Confirm panel is listed in NFPA 285 assembly.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Exposed-fastener, lap-seam metal wall panels.
 2. Concealed-fastener, lap-seam metal wall panels.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: **[As indicated on Drawings] <Insert loads>**.
 3. Deflection Limits: For wind loads, no greater than **[1/180] [1/240] <Insert deflection>** of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:
1. Test-Pressure Difference: **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.]**.
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
1. Test-Pressure Difference: **[2.86 lbf/sq. ft.] [6.24 lbf/sq. ft.]**.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
- F. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 EXPOSED-FASTENER, LAP-SEAM METAL WALL PANELS

- A. Provide factory-formed metal panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weathertight installation.

- B. V-shaped Rib -Profile, Exposed-Fastener Metal Wall Panels <Insert drawing designation>:
Formed with alternating v-shaped ribs spaced at 2.67 inches o.c. across width of panel.
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. AEP Span
 - b. Berridge
 - c. ATAS International, Inc.
 - d. CENTRIA, a Nucor Brand?.
 2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Pre-painted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Nominal Thickness: 0.028 inch 0.034 inch.
 - b. Exterior Finish: Two-coat fluoropolymer.
 - c. Color: As selected by Architect from manufacturer's full range.
 3. Aluminum Sheet: Coil-coated sheet, ASTM B209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
 - a. Thickness: [0.032 inch] [0.040 inch].

2.3 CONCEALED FASTENER, LAP-SEAM METAL WALL PANELS

- A. Provide factory-formed metal panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using concealed fasteners in side laps. Include accessories required for weather tight installation.
- B. [Flat Face] [Box-Rib] Profile, Concealed Fastener Metal Wall Panels:
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. AEP Span
 - b. Berridge.
 - c. ATAS International, Inc.
 - d. CENTRIA, a Nucor Brand
 - e. Or equal.
 2. Characteristics:
 - a. Panel Width: 12 inches
 - b. Profile height: 1-1/2 inch
 3. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Pre-painted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Nominal Thickness: 20 gage.

2.4 FINISHES

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

- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
 - 1. 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 [for seacoast and severe environments].
 - 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
- D. Aluminum Panels and Accessories:
 - 1. Two-Coat Fluoropolymer: AAMA 2605. 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 [for seacoast and severe environments].
 - 2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 - 3. Exposed Anodized Finish:
 - a. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
 - b. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 074213.23 - METAL COMPOSITE MATERIAL PANELS

GUIDELINES

1. *Verify panel gage and attachment method based on structural performance requirements.*
2. *System is specified as either DBVC drained and back-ventilated cavity rainscreen system designed to drain and dry water entering cavity through drainage channels, weeps, and air ventilation; or PER Pressure-equalized rainscreen system designed for no water intrusion, with equal pressure within air cavity and outside cladding barrier. Choose system as preferred. DBVC is typical.*
3. *Compliance with NFPA 285 is critical for MCM systems. Evaluate all test criteria for dimensions, air gap limitations, and fire blocking.*
4. *Use of Fire-Resistant core is specified as a recommended best practice.*
5. *Select MCM finish, typically aluminum.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Metal composite material (MCM) system – Exterior Walls.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: No failure or deterioration of the system when laterally racked to 3/4 inch in both directions and repeated for three cycles in accordance with AAMA 501.4. System must pass the static water test as described in ASTM E331 following the seismic racking.
- B. Structural Performance: MCM systems to withstand the effects of the following loads, based on testing in accordance with ASTM E330/E330M, as modified by CBC Chapter 16A:
 1. Wind Loads: As indicated on Structural Drawings.
 2. Other Design Loads: As indicated on Drawings.
 3. Deflection Limits: For wind loads, no greater than 1/1801/240 of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested in accordance with ASTM E283/E283M at the following test-pressure difference:
 1. Test-Pressure Difference: 1.57 lbf/sq. ft.
- D. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:
 1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- E. Water Penetration under Dynamic Pressure: No water penetration when tested in accordance with AAMA 501.1 at the following test pressure:
 1. Test Pressure: 6.24 psf.
- F. Pressure Cycling: Provide PER system with a pass rating in accordance with AAMA 508.
 1. Lag between the cavity and the cyclic wind pressure to not exceed 0.08 seconds.
 2. Maximum differential between the cavity and the cyclic wind pressure to not exceed 50 percent of the maximum test pressure.

- G. Provide DBVC system with V-axis classification number greater than or equal to W-axis classification number in accordance with AAMA 509.
- H. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- I. Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.
- J. Fire Propagation Characteristics: MCM system passes NFPA 285 testing.

2.2 METAL COMPOSITE MATERIAL (MCM) PANELS

- A. Metal Composite Material (MCM) Panels: Provide MCM panels fabricated from two metal facings bonded to a solid, extruded thermoplastic core.
 - 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. ALUCOBOND; 3A Composites USA, Inc – Basis of Design
 - b. ALPOLIC Materials; Mitsubishi Chemical Composites.
 - c. Reynobond
 - 2. Series: Alucobond Plus
 - a. Core: FR.
 - b. Standard core not acceptable.
 - 3. Panel Thickness: 0.157 inch.
 - 4. Bond Strength: 22.5 in-lb./in. when tested for bond integrity in accordance with ASTM D1781.
 - 5. Approval: ICC-ESR 1185
 - 6. Fire Performance: Flame-spread index less than 25 and smoke-developed index less than 450, in accordance with ASTM E84 or UL 723.
 - 7. Application: Exterior Wall and soffit
- B. MCM Panel Materials:
 - 1. Aluminum-Faced Panels : ASTM B209 alloy as standard with manufacturer, temper as required to suit finish and forming operations with 0.020-inch- thick, aluminum sheet facings, smooth surface finish.

2.3 METAL COMPOSITE MATERIAL (MCM) SYSTEM

- A. PER MCM System: Provide factory-formed and -assembled, MCM panels formed into profile for PER system installation, drained at horizontal joints and at base of wall. Include attachment assembly components, panel stiffeners, and accessories required for compartmentalized and weathertight system.
 - 1. Keith Panels
 - 2. Or equal.

- B. DBVC MCM System: Provide factory-formed and -assembled, MCM panels formed into profile for DBVC system installation, drained at horizontal joints and at base of wall. Include attachment assembly components, panel stiffeners, and accessories required for weathertight system.
 - 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. Elward
 - b. Citadel Architectural Products, Inc.
 - c. SAF (Southern Aluminum Finishing Company, Inc.).
- C. System Panel Depth: As indicated on drawings.
- D. Attachment Assembly Components: Manufacturer's standard formed from extruded aluminum.
- E. Labeling: Comply with labeling requirement of applicable building code.

2.4 CLADDING SUPPORT SYSTEM

- A. Provide MCM System cladding support per Section 074800.

2.5 ACCESSORIES

- A. Metal Sub framing and Furring: ASTM C955 cold-formed, metallic-coated steel sheet ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of MCM system.
 - 1. Rain Screen Wall Assemblies: Provide complete support framing and attachment system for installation of rain screen wall assemblies resulting in continuous insulated wall assembly when combined with insulation and cladding that is thermally isolated from structural wall framing by thermal spacers.
 - 2. Thermal Spacers: Refer to Section 074800 for thermal spacers.
- B. System Accessories: Provide components required for a complete, weathertight wall system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of MCM panels unless otherwise indicated.
- C. Flashing and Trim: Provide flashing and trim formed from same material as MCM panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, end walls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent MCM panels.
 - 1. Provide lap strap under flashing where flashing abut adjoining construction and seal lapped surfaces with full bed of non-hardening sealant.
- D. Panel Fasteners: Self-tapping or self-drilling screws designed to withstand design loads with EPDM or PVC sealing washers under heads of exposed fasteners and bearing on weather side of MCM panels. Use gasketed or approved coated fasteners between dissimilar metals.
 - 1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
 - 2. Exposed fasteners: With heads matching color of MCM panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners. Not acceptable unless approved by Architect.
 - 3. Bolts: Stainless steel.

4. Fasteners for Flashing and Trim: Blind fasteners of high-strength aluminum or stainless steel.
- E. Panel Sealants: Per Section 079200 and ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in MCM panels and remain weathertight; and as recommended in writing by MCM system manufacturer.

2.6 FABRICATION

- A. Fabricate and finish MCM panels at the factory, by panel manufacturer's standard procedures and processes, as necessary to fulfill indicated panel performance requirements demonstrated by laboratory testing.
- B. Shop-fabricate MCM systems and accessories by fabricator's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with requirements of MCM panel manufacturer, of indicated system profiles, and with dimensional and structural requirements.
 1. Fabricate panels to dimensions indicated on Drawings based on an assumed design temperature of 70 deg F. Allow for ambient temperature range at time of fabrication.
 2. Formed MCM panel lines, breaks, and angles to be sharp and straight, with surfaces free from warp or buckle.
 - a. Maximum permissible warpage of one corner out of the plane of the other three shall be 1/16 inch per foot distance from the nearest adjacent corner.
 3. Fabricate panels with sharply cut edges and no displacement of face sheet or protrusion of core.
 4. Fabricated Panel Tolerances: Shop-fabricate panels to sizes and joint configurations indicated on Drawings.
 - a. Width: Plus, or minus 0.079 inch at 70 deg F.
 - b. Length: Plus, or minus 0.079 inch at 70 deg F.
 - c. Squareness: Plus, or minus 0.079 inch at 70 deg F.
 5. Reveals and joints within panel
 - a. Joint location dimension from edge of panel: +/- 1/8 inch
 - b. Joint width: +/- 1/8 inch
 - c. Joint taper in 10 ft.: 1/4 inch maximum
 6. Fabricate MCM panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
 7. Attach routed-and-turned panel flanges to perimeter extrusions with manufacturer's standard fasteners or structural silicone adhesive.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's written instructions and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams.
 4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealants and to comply with SMACNA standards.

5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal manufacturer for application, but not less than thickness of metal being secured.

2.7 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: 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.
- C. Coil-Coated Metal Finish:
 1. PVDF Fluoropolymer: AAMA 2605, [two-coat][mica][metallic], fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating, including clear barrier coating, to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION - NOT USED

END OF SECTION 074213.23

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SECTION 074247 - UHPC WALL PANEL

GUIDELINES

1. Section uses fiber reinforced cement panels, produced under very high pressure and resulting density. Provides high impact strength panels complying with ASTM C1185 and C1186 Grade IV.
2. See 074248 GFRC wall panel section for alternate cement panel type.
3. Panels produced in multiple patterns, textures, and colors. Section includes example of finish option.
4. Typically used as a Rainscreen system, either PER or DBVC.
5. Comply with detailed required as an approved element in NFPA 285 assembly.

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Section includes:

1. Factory molded, ultra-high-performance concrete (UHPC) solid exterior wall panels and associated UHPC components
2. Engineered support structure (subframe), including all components required for attachment to building structure.
3. Fabrication for exterior applications, including factory cut and pre-drilling of holes for exposed fastening to the extent feasible for the installation and field conditions.

PART 2 - PRODUCTS

2.1 ULTRA HIGH-PERFORMANCE CONCRETE WALL PANEL (UHPC)

A. Manufacturers:

1. Taktl (basis of Design).
2. Envel.
3. Spring Valley.
4. Or equal

B. Series: TAKTL® Exterior Wall and Façade Panels.

1. Type 1: Gray UHPC Panels.
 - a. Three-part equal blend of custom gray/light tan color matching Architect's design reference sample for Type 1 panel.
 - b. Texture: Blend of cast and media blast texture matching Architect's design reference sample.
2. Type 2: Red UHPC Panels.
 - a. Three-part equal blend of custom red color matching Architect's design reference sample for Type 2 panel.
 - b. Texture: Blend of cast and media blast texture matching Architect's design reference sample.
3. Type 3: Vertical Textured UHPC Panel.
 - a. Color: Custom gray/light tan color with ColorSeal matching Architect's design reference sample for Type 3 panel.
 - b. Texture: Itero, cast texture matching Architect's sample for Type 3 panel.

C. Panel Performance Characteristics:

1. Thermal Expansion (ASTM C531-00): Maximum 6.41E-06 in/in/degree F (.01 inches per meter at 40-degree temperature change).

UHPC WALL PANEL

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2. Density - Thin Panel (ASTM C1185-08): Minimum 137 lbs./ft³ Freeze/Thaw (Cladding) (ASTM C1185-08): Pass. No visible cracks and not less than 90% post-exposure strength retention.
 4. Moisture Content - Thin Panel (ASTM C1185-08): less than 1.0%
 5. Moisture Movement - Thin Panel (ASTM C1185-08): 0.00%
 6. Warm Water (ASTM C1185-08): Pass. No visible cracks or structural alteration and not less than 90.0% ratio of retained post-exposure strength.
 7. Water Absorption - Thin Panel (ASTM C1185-08): less than 4.0%
 8. Water Tightness (ASTM C1185-08): Pass. No water droplet formation.
 9. Anchor Pullout Strength (ASTM E488-96): 10 mm embed in 16 mm thick panel.
 - a. Tension (Min. Mean) Peak Load - 692 lbf and factor of safety of 4.0.
 - b. Shear (Min. Mean) Peak Load - 1,187 lbf and factor of safety of 4.0.
 10. Surface Burning Characteristics (ASTM E84-09):
 - a. Flame Spread: Class A per ASTM E84.
 - b. Smoke Developed: Class A per ASTM E 84.
 11. NFPA 285 Compliance:
 - a. Provide documentation demonstrating panel is an approved element of an NFPA 285-2019 tested assembly.
 - b. Compliance shall be testing conducted using specified panel.
 - 1) Contractor may submit an engineering judgement, signed by a licensed fire protection engineer or approved equivalent, that panel meets NFPA 285-2019 test criteria, including panel joint placement.
 - c. Comply with Section 013513.35.
 12. Colorfastness & Weathering (500 hours) (ASTM G155-05a & D2244-09a):
 - a. Types 1 and 3: Average color change of 2.07 delta E. without coating based on all standard colors.
 - b. Type 2: Average color change of 3.5 delta E. without coating based on all standard colors.
 13. Compressive Strength (ASTM C109): Minimum 12,000 lbs./in².
 14. Finish exposed, front-facing surface of UHPC to match approved design reference sample. Panel faces to be free of joint marks, grain or other obvious defects.
- E. Panel Sizes: Panel sizes vary. Provide panels as indicated on Contract Documents and approved shop drawings.
- F. Panel Thickness: 5/8 inch.
- G. Panel Edges: As shown on drawings.
- 2.2 SUPPORT STRUCTURE
- A. Aluminum Support Structure:
1. Complete sub-frame assembly to support and anchor UHPC wall panels. Aluminum support structure shall be anchored to building structure.
- B. Components:
1. Vertically oriented support bracket/angle bracket anchored directly to building structure or framing, coordinated with specified continuous semi rigid board insulation.
 2. Horizontal girt profile, shelf shimming extrusions or cold formed channels that fasten into support brackets and supports.

3. Fasteners: Corrosion-resistant stainless-steel fasteners and anchors of type, size and spacing required for type of substrate and project conditions.

2.3 AUXILIARY MATERIALS

- A. Panel Fasteners: Exposed, for attaching UHPC panels to substructure support system
 1. Exposed Fastener: Head type and finish as selected by Architect.
- B. Panel anchor holes shall be factory pre-drilled by UHPC panel manufacturer.
- C. Adhesives & Sealants: As recommended in UHPC panel manufacturer's written instructions.
- D. Stainless Steel Drill Screws: Of sufficient lengths and sizes to securely fasten support structure to building wall framing members, and as follows:
 1. Screws complying with ASTM C 1002 for fastening to steel members less than 0.033 inches thick.
 2. Screws complying with ASTM C 954 for fastening to steel members from 0.033 to 0.112 inches thick.
- E. Miscellaneous Materials
 1. Aluminum Extrusions: ASTM B 221, Alloy 6005 T5.
 2. Aluminum Sheet: ASTM B 209, Alloy 6061-T5
 3. Carbon Steel Shapes and Plates: ASTM A 36, finished as follows
 - a. Hot dipped galvanized
 4. Stainless steel Bars and shapes: ASTM A 276, Type 304 or better.

2.4 ACCESSORIES

- A. Trim:
 1. Closed Joint: Birds beak joint profile, powder coated, color as selected by Architect from full range.
 2. Prefabricated Mitered Corner: Factory fabricated mitered corner, refer to Drawings for locations.
 3. Other trim as indicated on Drawings.

2.5 FABRICATION

- A. Fabricate wall panels and accessory items in accordance with manufacturers' recommendations and approved submittals.
- B. Panels shall be fabricated to size, with all exposed, face fastened anchor holes factory-drilled for recessed fasteners by the UHPC panel manufacturer.
- C. Field-cut panels and drill face-fastening anchor holes in accordance with the UHPC panel manufacturer's written directions.
- D. Fabricate all panels to profiles, colors and textures per samples and approval selected by the Architect.
- E. Fabricate panels in accordance with manufacturers' Quality Management System Tolerances and Acceptance Criteria.

2.6 FABRICATION TOLERANCES

- A. Manufacturing Tolerances: Manufacture UHPC panels so each finished unit complies with the following dimensional tolerances.
 - 1. Overall Height and Width of Units, Measured at the Face Adjacent to Mold: plus, or minus 1/16 inch.
 - 2. Weight of finished panels not to exceed 7.4 pcf.
 - 3. Edge Return Thickness: Plus 5/8 inch, minus zero inch.
 - 4. Texture and Reveal Depth: Maximum 1/8 inch.
 - 5. Thickness: Plus 5/8 inch, plus/minus 1/16 inch per ASTM C1185.
 - 6. Variation from Square or Designated Skew (Difference in Length of Two Diagonal Measurements): Plus, or minus 1/16 inch per 72 inches or plus or minus 1/8-inch total, whichever is greater.
 - 7. Local Smoothness: 1/8-inch per 10 feet.
 - 8. Bowing: Not to exceed L/240 unless unit complies with erection tolerances using connection adjustments.
 - 9. Length and Width of Block Outs and Openings within One Unit: Plus, or minus 1/4 inch.
 - 10. Location of Window Opening within Panel: Plus, or minus 1/4 inch.
 - 11. Maximum Permissible Warpage of One Corner out of the Plane of the Other Three: 1/16 inch per 12 inches of distance from nearest adjacent corner.
- B. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.
- C. Panel Alignment: Plus, or minus 1/8-inch.
- D. Special Handling Devices: Plus, or minus 3-inches. (where applicable)
- E. Location of Bearing Devices: Plus, or minus 1/16-inch.
- F. Cutouts: Plus, or minus 3/8-inch. Refer to manufacturer's guide to cutouts and notching of panels in the field cutting instructions.
- G. Color Variation and Aggregate Distribution Variation Acceptance Criteria: Per Manufacturer's Tolerances and Acceptance Criteria.
- H. Blemishes and Chips Acceptance Criteria: Per Manufacturer's Tolerances and Acceptance Criteria.
- I. Acceptance of installed panels shall be assessed when viewed from a distance of 20 feet, under even light, and from a position 90 degrees to the building elevation.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 074248 - GFRC WALL PANEL

GUIDELINES

1. Section uses fiber reinforced cement panels complying with ASTM C1185 and C1186 Grade II.
2. See 074247 UHPC wall panel section for alternate high strength cement panel type.
3. Panels produced in multiple patterns, textures, and colors. Section includes example of finish option.
4. Typically used as a Rainscreen system, either PER or DBVC.
5. Comply with detailed required as an approved element in NFPA 285 assembly.

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Section includes:

1. Factory molded, glass fiber reinforced (GFRC) solid exterior wall panels and associated components
2. Engineered support structure (subframe), including all components required for attachment to building structure.
3. Fabrication for exterior applications, including factory cut and pre-drilling of holes for exposed fastening to the extent feasible for the installation and field conditions.

PART 2 - PRODUCTS

2.1 GFRC WALL PANEL

A. Manufacturers:

1. Rieder.
2. Or equal.

B. Series: Rieder Concrete Skin.

1. Type 1: Tan.
 - a. Three-part equal blend of:
 - 1) Color: Sahara.
 - 2) Finish: Ferro, Ferro Light, Ferro Plus.
 - b. Texture: Standard.
2. Type 2: Red.
 - a. Three-part equal blend of:
 - 1) Color: Oxide Red.
 - 2) Finish: Ferro, Ferro Light, Ferro Plus.
 - b. Texture: Standard.
3. Type 3: Vertical Textured GFRC Panel.
 - a. Color: Vanilla.
 - b. Finish: Matte.
 - c. Texture: Groove.

C. Panel Performance Characteristics:

1. Density - Thin Panel (ASTM C1186-08): 204 lbs./ft³. Flexural Strength (Thin Panel) - Wet (ASTM C1186-08): Pass, Mean length direction not less than 2,610 lbs./in² and width direction 2,610 lbs./in².
3. Freeze/Thaw (Cladding) (ASTM C1186-08): Pass. No visible cracks.
4. Moisture Content - Thin Panel (ASTM C1186-08): Less than 1.2%.
5. Moisture Movement - Thin Panel (ASTM C1186-08): 0.02%
6. Warm Water (ASTM C1186-08): Pass. No visible cracks or structural alteration.
7. Water Absorption - Thin Panel (ASTM C1186-08): Less than 3.4%
8. Water Tightness (ASTM C1186-08): Pass. No water droplet formation.
9. Surface Burning Characteristics (ASTM E84-09):
 - a. Flame Spread: Class A per ASTM E84.
 - b. Smoke Developed: Class A per ASTM E 84.
10. NFPA 285 Compliance:
 - a. Provide documentation demonstrating panel is an approved element of an NFPA 285-2019 tested assembly.
 - b. Compliance shall be testing conducted using specified panel.
 - 1) Contractor may submit an engineering judgement, signed by a licensed fire protection engineer or approved equivalent, that panel meets NFPA 285-2019 test criteria, including panel joint placement.
11. Colorfastness & Weathering (ASTM G155-05, 2000 hours, 5X magnification): Pass - no cracking, checking, erosion or other performance affecting conditions.
12. Design Reference Sample: As provided by Architect.

D. Panel Sizes: Vary and as indicated on approved panel/part layout.

E. Panel Thickness: As shown on drawings and as required for structural load resistance.

F. Panel Edges: As shown on drawings

2.2 SUPPORT STRUCTURE - DELEGATED DESIGN

A. Aluminum Support Structure:

1. Complete sub-frame assembly to support and anchor GFRC wall panels. Aluminum support structure shall be anchored to building structure.

B. Components:

1. Vertically oriented support bracket/angle bracket anchored directly to building structure, coordinated with specified continuous semi rigid board insulation.
2. Horizontal girt profile, shelf shimming extrusions or cold formed channels that fasten into support brackets and supports.
3. Fasteners: Corrosion-resistant stainless-steel fasteners and anchors of type, size and spacing required for type of substrate and project conditions.

2.3 AUXILIARY MATERIALS

A. Panel Fasteners: Exposed, for attaching GFRC panels to substructure support system

1. Exposed Fastener: Head type and finish as selected by Architect. Where feasible, recess fastener head below panel surface.

B. Panel anchor holes shall be factory pre-drilled by GFRC panel manufacturer.

C. Adhesives & Sealants: As recommended in GFRC panel manufacturer's written instructions.

- D. Stainless Steel Drill Screws: Of sufficient lengths and sizes to securely fasten support structure to building wall framing members, and as follows:
 - 1. Screws complying with ASTM C 1002 for fastening to steel members less than 0.033 inches thick.
 - 2. Screws complying with ASTM C 954 for fastening to steel members from 0.033 to 0.112 inches thick.
- E. Miscellaneous Materials
 - 1. Aluminum Extrusions: ASTM B 221, Alloy 6005 T5.
 - 2. Aluminum Sheet: ASTM B 209, Alloy 6061-T5
 - 3. Carbon Steel Shapes and Plates: ASTM A 36, finished as follows:
 - a. Hot dipped galvanized.
 - 4. Stainless Steel Bars and Shapes: ASTM A 276, Type 304 or better.

2.4 ACCESSORIES

- A. Trim:
 - 1. Closed Joint: Birdsbeak joint profile, powder coated, color as selected by Architect from full range.
 - 2. Closed Corner: Fry Reglet RCT-50 rounded corner trim, powder coated, color as selected by Architect from full range.
 - 3. Prefabricated Mitered Corner: Factory fabricated mitered corner, refer to Drawings for locations.
 - 4. Other trim as indicated on Drawings.

2.5 FABRICATION

- A. Fabricate wall panels and accessory items in accordance with manufacturers' recommendations and approved submittals.
- B. Panels shall be fabricated to size, with all exposed, face fastened anchor holes factory-drilled for recessed fasteners by the GFRC panel manufacturer.
- C. Field-cut panels and drill face-fastening anchor holes in accordance with the GFRC panel manufacturer's written directions.
- D. Do not field-modify factory-drilled panel anchor holes.
- E. Fabricate all panels to profiles, colors and textures per samples and approval selected by the Architect.
- F. Fabricate panels in accordance with manufacturers' Quality Management System Tolerances and Acceptance Criteria.

2.6 FABRICATION TOLERANCES

- A. Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with the following dimensional tolerances.
 - 1. Overall Height and Width of Units, Measured at the Face Adjacent to Mold: plus, or minus 1/8 inch.
 - 2. Edge Return Thickness: Plus 5/8 inch, minus zero inch.
 - 3. Texture and Reveal Depth: Maximum 1/8 inch.
 - 4. Thickness: 3.9 percent within the sheet; sheet to sheet 0.03 inch.
 - 5. Variation from Square: Plus, or minus 1/32 inch per 12 inches.
 - 6. Edge Straightness: Plus, or minus 1/32 inch per 12 inches.
 - 7. Local Smoothness: 1/8 inch per 10 feet.

GFRC WALL PANEL

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- B. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.
- C. Panel Alignment: Plus, or minus 1/8 inch.
- D. Special Handling Devices: Plus, or minus 3 inches (where applicable).
- E. Location of Bearing Devices: Plus, or minus 1/16 inch.
- F. Cutouts: Plus, or minus 3/8 inch. Refer to manufacturer's guide to cutouts and notching of panels in the field cutting instructions.
- G. Color Variation and Aggregate Distribution Variation Acceptance Criteria: Per Manufacturer's Tolerances and Acceptance Criteria.
- H. Blemishes and Chips Acceptance Criteria: Per Manufacturer's Tolerances and Acceptance Criteria.
- I. Acceptance of installed panels shall be assessed when viewed from a distance of 10 feet, under even light, and from a position 90 degrees to the building elevation.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 075419 - POLYVINYL-CHLORIDE (PVC) ROOFING

GUIDELINES

1. *Systems shown is for adhered membrane placed on cover board over insulation adhered to concrete substrate. Modify for placement on wood sheathing or metal deck.*
2. *Multiple insulation materials are specified. Select based on market availability. Establish R-Value required and adjust roof assembly based wind uplift.*
3. *Establish warranty criteria. Specified system achieves 20 year NDL warranty.*
4. *Define wind uplift criteria, including FM Global or SPRI calculation method. Select use of FM Global or SPRI/CBC approach.*
5. *Verify wind speed and loads are shown on drawings.*
6. *Membrane leak detection (ELD) system shown is low cost and immediate quality control procedure. Other methods are available.*

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adhered polyvinyl chloride (PVC) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Membrane Integrity/Leak Detection Testing
8. Electronic leak detection (ELD) materials.
9. Walkways.
10. Address Numerals

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.
1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
 2. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:
1. Zone 1 (Roof Area Field): As shown on Structural Drawings <Insert lbf/sq. ft.>.

POLYVINYL-CHLORIDE (PVC) ROOFING

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2. Zone 2 (Roof Area Perimeter): As shown on Structural Drawings <Insert lbf/sq. ft.>.ol style="list-style-type: none;"> - a. Location: From roof edge to As shown on Structural Drawings <Insert dimension> inside roof edge.
3. Zone 3 (Roof Area Corners): As shown on Structural Drawings <Insert lbf/sq. ft.>.ol style="list-style-type: none;">- a. Location: As shown on Structural Drawings <Insert dimension> in each direction from building corner.
- D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
 1. Fire/Windstorm Classification: [Class 1A-60] [Class 1A-75] [Class 1A-90] [Class 1A-105] [Class 1A-120] <Insert class>.
 2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 [MH] [SH].
- E. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.
 1. Wind Uplift Load Capacity: [60 psf] [75 psf] [90 psf] [105 psf] [120 psf] <Insert capacity>.
- F. Exterior Fire-Test Exposure: ASTM E108 or UL 790, [Class A] [Class B] [Class C]; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Foam insulation shall comply with CBC 2603.6, and be specifically listed as a component of a Class A roofing assembly tested in accordance with ASTM E 108 or UL 790
- G. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.
- H. Sustainable Design Requirements: Provide products in accordance with the requirements as specified :
 1. Recycled content.
 2. Adhesives, sealants, primers: Comply with SCAQMD VOC content and VOC emissions regulations.
- I. Manufacturers Roof Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
 1. Special total system warranty includes membrane roofing, base flashings, liquid applied flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, coping, edge flashings, sealants used within the roof membrane assembly, and other components of membrane roofing system.
 2. Provide warranty rider covering peak gust wind speed loads shown on structural drawings. Standard warranty wind speed of 55 miles per hour not acceptable.
 3. Warranty Period: 20 years total system warranty from date of Substantial Completion.
- ## 2.2 POLYVINYL CHLORIDE (PVC) ROOFING
- A. Type: PVC Sheet Type II: ASTM D4434/D4434M, glass-fiber reinforced, felt backed.
 - B. 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. Sika Sarnafil.
 2. Soprema, Inc.

- C. Series: Sarnafil G410, Energy Smart, felt back, fully adhered.
 - 1. Membrane Thickness: minimum 72 mils. Thickness defined as PVC membrane thickness excluding felt or fleece backing thickness.
- D. Sustainability Characteristics, based on EnergySmart White:
 - 1. Initial Solar Reflectance: 0.85 per ASTM C1589
 - 2. Solar Reflectance at 3 Years: 0.74 per ASTM C1589
 - 3. Initial Thermal Emittance: 0.86 per ASTM C1371
 - 4. Thermal Emittance at 3 Years: 0.84 per ASTM C1371
 - 5. Initial Solar Reflectance Index: 107
 - 6. Solar Reflectance Index at 3 Years: 90.
- E. Characteristics based on 72 mil total mil membrane excluding backing thickness:
 - 1. Thickness: 35 mil measured over scrim.
 - 2. Breaking Strength: 100 lbf per ASTM D751
 - 3. Tearing Resistance: 20.5 lbf per D1004
 - 4. Static Puncture Resistance: Minimum 33 lbf per ASTM D 5602
 - 5. Field Seam Strength: Minimum 75 lbf/inch per ASTM D1876.
 - 6. Water vapor permeance, Perms: 0.10 maximum per ASTM E96, Procedure B.
 - 7. Properties after heat aging: Per ASTM D3045.
 - a. Retained Breaking Strength: 90 percent minimum
 - b. Retained Tearing Strength: 90 percent minimum
 - 8. Weight Change after Immersion: 1.8 percent per ASTM D570
 - 9. Resistance to Water Absorption: Max 0.90 percent per D471, 7 days immersion.
 - 10. Weathering Resistance: Per ASTM G154, Fluorescent, 10,000 hours.
 - a. No cracks, loss of breaking or tearing strength..
- F. Finish and Color:
 - 1. Finish: Factory Applied lacquer coating.
 - 2. Exposed Face Color: Complying color as selected by Architect.

2.3 ACCESSORY ROOFING MATERIALS

- A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
 - 1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet.
- C. PVC Clad Sheet Metal Flashing: PVC clad flashing, gage as required by roofing system manufacturer, color as selected by Architect.
- D. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- E. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- G. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, pre-punched.

- H. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- I. Address numerals: Provide high gloss exterior acrylic paint coating approved by roofing membrane manufacturer and suitable for painting address numerals on roof membrane.
 - 1. Provide 4 different numerals, placed within a 36-inch square panel.
 - 2. Type style: Helvetica
 - 3. Color: White on dark tan background within 36 inch square panel.
 - 4. Orientation: As directed by Architect.
- J. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARD

- A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.
 - 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. Georgia-Pacific Gypsum LLC.
 - b. National Gypsum Company.
 - c. USG Corporation.
 - 2. Thickness: Type X, 5/8 inch.
 - 3. Surface Finish: Factory primed.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 VAPOR RETARDER

- A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.
 - 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Carlisle Coatings & Waterproofing, Div. of Carlisle Companies Inc.; Dri-Start "A."
- B. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

2.6 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved] by PVC roof membrane manufacturer, approved for use in FM Approvals' RoofNav listed roof assemblies, approved for use in SPRI's Directory of Roof Assemblies listed roof assemblies, free of CFC or HCFC blowing agents.

- B. Extruded-Polystyrene Board Insulation: ASTM C578, Type IV, 1.45-lb/cu. ft., square edged.
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. Dow Chemical Company (The).
 - b. Owens Corning.
 2. Thermal Resistance: R-value of 5.0 per 1 inch.
 3. Size: 48 by 48 inches.
 4. Thickness:
 - a. Base Layer: [1-1/2 inches] <Insert thickness>.
 - b. Upper Layer: <Insert thickness>.
- C. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, 1.15-lb/cu. ft. minimum density, 13-psi minimum compressive strength, square edge.
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. Atlas Roofing Corporation.
 - b. Carlisle.
 2. Thermal Resistance: R-value of 3.8 per 1 inch.
 3. Size: 48 by 48 inches.
 4. Thickness:
 - a. Base Layer: [1-1/2 inches] <Insert thickness>.
 - b. Upper Layer: <Insert thickness>.
- D. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2 Type II, Class 2, Grade 2 Type II, Class 1, Grade 3, felt or glass-fiber mat facer on both major surfaces.
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. Atlas Roofing Corporation.
 - b. Carlisle Incorporated.
 - c. Johns Manville; a Berkshire Hathaway company.
 2. Compressive Strength: 20 psi.
 3. Size: 48 by 48 inches.
 4. Thickness:
 - a. Base Layer: [1-1/2 inches] <Insert thickness>.
 - b. Upper Layer: <Insert thickness>.
- E. Tapered Insulation: Provide factory-tapered insulation boards.
1. Material: [Match roof insulation] <Insert material>.
 2. Minimum Thickness: 1/4 inch.
 3. Slope:
 - a. Roof Field: [1/4 inch per foot] <Insert slope> unless otherwise indicated on Drawings.
 - b. Saddles and Crickets: [1/2 inch per foot] <Insert slope> unless otherwise indicated on Drawings. Slope to drain.

2.7 INSULATION ACCESSORIES AND COVER BOARD

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
- D. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.
 - 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. Georgia-Pacific Gypsum LLC.
 - b. National Gypsum Company.
 - c. USG Corporation.
 - 2. Thickness: 1/2 inch 5/8 inch.
 - 3. Surface Finish: Factory primed.

2.8 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Roof Coping Series and Characteristics:
 - 1. General: Factory prefabricated metal roof flashings, approved for use in FM Approvals RoofNav-listed roof assemblies and compliant with CBC/SPRI ES-1 requirements.
 - 2. Manufacturer:
 - a. Metal-Era.
 - b. Roof membrane manufacturers labeled flashings
 - c. Or equal.
 - 3. Series: SecurEdge 200, Cantilever design where shown, decorative metal coping, factory custom fabricated, version/profile as shown on drawings.
 - 4. Material and Gage:
 - a. Coping Cover: Extruded aluminum, 0.063 inch.
 - b. Anchor/Support Cleat: 16 gauge pre-punched galvanized cleat with stainless steel spring mechanically locked to cleat normally 12 inch wide at 3 foot 0 inch on center. Mechanically fastened as indicated and detailed.
 - c. Concealed Splice Plates: 8 inch wide. Finish to match finish of coping cap with factory applied dual non-curing sealant strips.
 - 5. Size: Provide dimension as shown on drawings.
 - 6. Accessory Fabrications: Provide factory fabricated transitions and fabrications as required.
 - a. Corners: Provide welded corners, 12-inch leg each side.
 - 7. Fasteners: Stainless steel fasteners, #10 x 2 inch. No exposed fasteners permitted.
 - 8. Finish:
 - a. AAMA 2605 compliant system with clear barrier coat as required by manufacturer. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

9. Color: As selected by Architect from manufacturer's full range of standard colors.

B. Roof Edge Series and Characteristics:

1. General: Factory prefabricated metal roof flashings, approved for use in FM Approvals RoofNav-listed roof assemblies and compliant with CBC/SPRI ES-1 requirements.
2. Manufacturer:
 - a. Metal-Era.
 - b. Roof membrane manufacturers labeled flashings
 - c. Or equal.
3. Series: Metal Era Anchor Tite Standard Fascia metal edge.
4. Material and Gage:
 - a. Cover: Extruded aluminum, 0.040 inch.
 - b. Anchor/Support Cleat: Provide continuous 22 gauge pre-punched galvanized cleat with stainless steel spring mechanically locked to cleat normally 12 inch wide at 3 foot 0 inch on center. Mechanically fastened as indicated and detailed.
 - c. Concealed Splice Plates: 8 inch wide. Finish to match finish of coping cap with factory applied dual non-curing sealant strips.
 - d. Size: Provide dimension as shown on drawings.
5. Accessory Fabrications:
 - a. Provide factory fabricated transitions and fabrications as required.
 - b. Provide Anchor-Tite prefinished scupper and downspout assemblies as shown on drawings.
6. Fasteners: Stainless steel fasteners, #10 x 2 inch. No exposed fasteners permitted.
 - a. AAMA 2605 compliant, with clear barrier coat as required by manufacturer at exterior. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
7. Color: As selected by Architect from manufacturer's full range of standard colors.

2.9 MEMBRANE INTEGRITY/LEAK DETECTION SYSTEM

- 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. Detec Systems.
 2. Or equal.
- B. Type: Membrane integrity/leak detection system, suitable for testing non-conductive roof and waterproofing membranes installed on cover board for breaches in membrane in accordance with ASTM D8231.
- C. Conductive Primer:
1. Detec Systems, TruGround Conductive Primer - Basis of Design
 2. Suitable for application over roof system coverboard.
 3. Characteristics:
 - a. Odor: Odorless
 - b. Solids by Volume: 23.2%
 - c. Solids by Weight: 13%
 - d. Weight per Gallon: 8.2 lb
 - e. Tints (pigments) carbon black
 - f. Primary Material: water based epoxy resin

D. Fire/Life Safety/Habitability:

1. VOC: Comply with SCAQMD regulations
2. Flame Spread: Class A per ASTM E 84

E. Approvals:

1. Approved as a component of FM Global approved roof membrane assembly.
2. Approved for use in Class A fire resistant roof assemblies.

F. Accessories: Provide all accessories required for temporary conductive testing.

G. Testing Equipment:

1. Low Voltage Scanning Platform: Portable wheel-mounted sweeper unit with audible and visual alarms.
2. Low Voltage Vertical Scanning Unit (VSU): Portable water absorptive roller device with audible and visual alarms.

2.10 WALKWAYS

A. Walkways: Additional layer of roofing membrane fully adhered.

1. Color: Contrasting with roof membrane.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 076200 - SHEET METAL FLASHING AND TRIM

GUIDELINES

1. *Coordinate flashing assemblies with roof detailing. Coping and edge flashing are specified in Section 075419 for "edge to edge" warranty inclusion.*
2. *Comply with specified wind load criteria for all flashing.*
3. *Exposed flashing is specified as prefinished metallic coated steel (galvanized sheet metal). Unless specified otherwise in section 075419, stainless steel flashing specified for all other conditions for maximum corrosion resistance. Review use of heavy gage and G90 galvanized sheet metal with District for reduced cost.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Manufactured Products:
 - a. Manufactured reglets with counterflashing.
 2. Formed Products:
 - a. Formed sheet metal fabrications.
 - b. Formed roof-drainage sheet metal fabrications.
 - c. Formed low-slope roof sheet metal fabrications.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install **[copings]** **[roof edge flashings]** tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
 1. Design Pressure: **As indicated on Structural Drawings.**
- D. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
 - 1. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
 - 2. Finish: ASTM A480/A480M, No. 2B (bright, cold rolled).
- C. Metallic-Coated Steel Sheet: Provide aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40; pre-painted by coil-coating process to comply with ASTM A755/A755M.
 - 1. Surface: Smooth, flat.
 - 2. Exposed Coil-Coated Finish:
 - a. AAMA 2605 compliant. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions,
 - b. Color: <Insert color>

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal flashing assemblies. Provide primer in accordance with underlayment manufacturer's written instructions.
 - 1. Manufacturers:
 - a. Carlisle
 - b. Or equal.
 - 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carlisle WIP 300HT.

MISCELLANEOUS MATERIALS

- A. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- B. Elastomeric Sealant: ASTM C920, **silicone** polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- C. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- D. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
 - 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. Cheney Flashing Company.
 - b. Fry Reglet Corporation.
 - c. Heckmann Building Products, Inc.

SHEET METAL FLASHING AND TRIM

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2. Material: Stainless steel, Type 304, 0.020 inch thick.
3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
4. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
5. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
6. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
7. Accessories:
 - a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
 - b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.

2.5 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters:

1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
2. Fabricate in minimum 96-inch- long sections.
3. Furnish flat-stock gutter brackets and **flat-stock** gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness [**dimension indicated on Drawings**].
4. Fabricate expansion joints, expansion-joint covers, [**gutter bead reinforcing bars,**] and gutter accessories from same metal as gutters. [**Shop fabricate interior and exterior corners.**]
5. Gutter Profile: As indicated on Drawings.
6. Gutter Profile: in accordance with cited sheet metal standard.
7. Expansion Joints: **Butt type with cover plate.**
8. Accessories: **Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.**
9. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
 - a. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] **<Insert dimension>** thick.
10. Gutters with Girth 16 to 20 Inches: Fabricate from the following materials:
 - a. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] **<Insert dimension>** thick.
11. Gutters with Girth 21 to 25 Inches: Fabricate from the following materials:
 - a. Aluminum-Zinc Alloy-Coated Steel: [0.034 inch] **<Insert dimension>** thick.

B. Downspouts: Fabricate downspouts to profile and dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.

1. Hanger Style: As indicated on Drawings.
2. Fabricate from the following materials:
 - a. Aluminum: 0.024 inch thick.
 - b. Galvanized Steel: 0.022 inch thick.

C. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch- () wide wall flanges to interior, and base extending 4 inches () beyond cant or tapered strip into field of roof. Fabricate from the following materials:

1. Galvanized Steel: [0.028 inch ()] **<Insert dimension>** thick.

- D. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes [, exterior flange trim,] [and] [built-in overflows]. Fabricate from the following materials:
1. Galvanized Steel: [0.028 inch] <Insert dimension> thick.

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 078100 - APPLIED FIREPROOFING

GUIDELINES

1. *Two Systems specified: First for projects up to 75 feet, Second for greater than 75 feet but less than 420 feet.*
2. *SFRM can be troweled to achieve more finished appearance. Modify as required.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes sprayed fire-resistive materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Assemblies: Provide wet-mix fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.
 1. Comply with provisions of applicable state and local codes.
 2. Ensure application of SFRM complies with requirements of fire-resistance design and manufacturer's written instructions including, but not limited to, minimum thickness and dry density of applied SFRM, method of application, substrate surface conditions, and use of bonding adhesives, sealants, reinforcing or other materials.
- B. Source Limitations: Obtain fireproofing **for each fire-resistance design** from single source.
- C. Fire-Resistance Design: Indicated on Drawings, tested according to **ASTM E 119 or UL 263**; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Fire-Resistance Ratings: Indicated on Drawings by design designations in UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. UL design designation indicated on Drawings includes statement that the loading was determined by Allowable Stress Design Method or Load and Resistance Factor Design Method. UL design designations requiring load restriction factor not acceptable.
 2. Steel members are to be considered unrestrained unless specifically noted otherwise.
- D. Low-Emitting Materials: For field applications, coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Asbestos: Provide products containing no detectable asbestos.
- F. Dry-Mix Materials: Dry mix sprayed fireproofing materials containing mineral fiber are not acceptable.

2.2 SPRAYED FIRE-RESISTIVE MATERIALS

- A. SFRM-15/150: Manufacturer's standard, factory-mixed, complying with indicated fire-resistance design and mixed with water at Project site to form a slurry or mortar before conveyance and application.
- Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
 - Carboline Company, Southwest Type 5GP.
 - Grace, W. R. & Co. - Conn.; Grace Construction Products; Monokote Z-106G or Monokote MK-6.
 - Isolatek International; Cafco 300
 - Application: Designated by qualified testing agency acceptable to authorities having jurisdiction for interior, concealed use for buildings up to 75 feet above lowest level of fire department vehicle access.
 - Bond Strength: Minimum 150-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E 736.
 - Density: Not less than 15 lb/cu. ft. (240 kg/cu. m) as specified in the approved fire-resistance design, according to ASTM E 605.
 - Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E 605, whichever is thicker, but not less than 0.375 inch.
 - Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - Flame-Spread Index: 10 or less.
 - Compressive Strength: Minimum 10 to 30 lbf/sq. in. according to ASTM E 761.
 - Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
 - Deflection: No cracking, spalling, or delamination according to ASTM E 759.
 - Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
 - Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours according to ASTM E 859.
 - Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in **no growth on specimens per ASTM G 21 or rating of 10 according to ASTM D 3274 when tested according to ASTM D 3273.**
 - Finish: **[Spray-textured finish] [Rolled, spray-textured finish] [Skip-troweled finish]**
<Insert requirement.>
 - Apply separate topcoat after finishing.
 - Color of Topcoat: **Match Architect's sample .**
- B. SFRM-15/430: Manufacturer's standard, factory-mixed, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application.
- Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
 - Carboline Company, Southwest Type 5MD.
 - Grace, W. R. & Co. - Conn.; Grace Construction Products; Monokote Z-106G or Monokote MK-10HB.
 - Isolatek International; Cafco 300 HS.
 - Application: Designated by qualified testing agency acceptable to authorities having jurisdiction for interior, exposed to view use for buildings between 75 and 420 feet above lowest level of fire department vehicle access.

3. Bond Strength: Minimum 430-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E 736.
 4. Density: Not less than 15 lb/cu. ft. (240 kg/cu. m) as specified in the approved fire-resistance design, according to ASTM E 605.
 5. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E 605, whichever is thicker, but not less than 0.375 inch.
 6. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 10 or less.
 - b. Smoke-Developed Index: 10 or less.
 7. Compressive Strength: Minimum 10 lbf/sq. in. according to ASTM E 761.
 8. Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
 9. Deflection: No cracking, spalling, or delamination according to ASTM E 759.
 10. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
 11. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours according to ASTM E 859.
 12. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in **no growth on specimens per ASTM G 21 or rating of 10 according to ASTM D 3274 when tested according to ASTM D 3273.**
 13. Finish: **[Spray-textured finish] [Rolled, spray-textured finish] [Skip-troweled finish].**
 - a. Apply separate topcoat after finishing.
 - b. **Color of Topcoat: Match Architect's sample .**
- C. Sprayed Fire-Resistive Material <Insert drawing designation or UL-design number>: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and [mixed with water at Project site to form a slurry or mortar before conveyance and application] [or] [conveyed in a dry state and mixed with atomized water at place of application].
1. Compressive Strength: Minimum 10 lbf/sq. in. 100 lbf/sq. in. according to ASTM E 761.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:
1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E 736.
- C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

- D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and fireproofing manufacturer's written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive fireproofing.
- E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by fireproofing manufacturer.
- F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fireproofing manufacturer. Include pins and attachment.
- G. Topcoat: Suitable for application over applied fireproofing; of type recommended in writing by fireproofing manufacturer for each fire-resistance design.
 - 1. Cement-Based Topcoat: Factory-mixed, cementitious hard-coat formulation for trowel or spray application over SFRM.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 078123 - INTUMESCENT FIRE PROTECTION

GUIDELINES

1. *There are no industry standards for intumescent finish. Establish basic finish and then use Architect approved sample process. Suggest sample includes basic connection condition.*
2. *Include finish coating and color on sample.*
3. *Strongly recommend shop applied fire protection for most projects, with field applied repair and connection infill.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Water-based intumescent fire-resistive coatings.
- B. Application:
 1. Steel structural elements.
 2. Steel structural connection elements.
 3. Wood timber / CLT exposed steel connectors.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Assemblies: Provide fire protection, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.
- B. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.
 1. Comply with provisions of applicable state and local codes.
 2. Ensure application of SFRM complies with requirements of fire-resistance design and manufacturer's written instructions including, but not limited to, minimum thickness and dry density of applied SFRM, method of application, substrate surface conditions, and use of bonding adhesives, sealants, reinforcing or other materials.
- C. Source Limitations: Obtain fireproofing **for each fire-resistance design** from single source.
- D. Fire-Resistance Design: Indicated on Drawings, tested according to **ASTM E 119 or UL 263**; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Fire-Resistance Ratings: Indicated on Drawings by design designations in UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. UL design designation indicated on Drawings includes statement that the loading was determined by Allowable Stress Design Method or Load and Resistance Factor Design Method. UL design designations requiring load restriction factor not acceptable.
 2. Steel members are to be considered unrestrained unless specifically noted otherwise.
- E. Source Limitations: Obtain fire protection **for each fire-resistance design** from single source.

- F. Fire-Resistance Design: Indicated on Drawings, tested according to **ASTM E119 or UL 263**; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- G. Low-Emitting Materials: For field applications, coatings shall comply with the requirements of the SCAQMD and California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- H. Asbestos: Provide products containing no detectable asbestos.

2.2 WATER-BASED INTUMESCENT FIRE-RESISTIVE COATINGS

- A. Water-Based Intumescent Fire-Resistive Coating: Manufacturer's standard, factory-mixed formulation or factory-mixed, multicomponent system consisting of intumescent base coat and topcoat, and complying with indicated fire-resistance design.
- B. Manufacturer and Product
 - 1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
 - a. Hilti FireFinish, series suitable for application.
 - b. Sherwin Williams, Firefree, series suitable for application
 - c. Carboline Company, ; AD Firefilm, series suitable for application..
 - d. Isolatek International, Cafco Spray Film, series suitable for application.
- C. Characteristics
 - 1. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design.
 - 2. Durometer Hardness: minimum 63, Shore D per ASTM D2240
 - 3. Impact Resistance: Greater than 65 in/lb per ASTM D2794
 - 4. Abrasion Resistance: Maximum 0.23 gram/1000 cycles per ASTM D4060
 - 5. Adhesion: Greater than 350 psi per ASTM D4541
 - 6. Surface-Burning Characteristics: Class A per ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame spread Index: 15 or less
 - b. Smoke-Developed Index: **50** or less.
 - 7. Finish: .
 - a. Finish at Concealed locations: Manufacturers standard [roll] [or] [spray] texture.
 - b. Finish at Exposed to view locations: Unless otherwise indicated, Roller smooth finish for final finish paint, following connector profile, free of ridges, gouges, or uneven surfaces.
 - c. At wood timber exposed steel connectors, apply as required to obtain uniform surface, following connector profile, free of ridges, gouges, or uneven surfaces.
 - d. Color and Gloss: As indicated by manufacturer's designations.
 - 8. Topcoat:
 - a. Interior Application: Provide finish paint system as specified in Section 099123, approved as compatible in writing by fireproofing manufacturer for each fire-resistance design, SCAQMD VOC compliant, color and sheen as selected by Architect.

- b. Exterior Application: Provide finish paint system as specified in Section [099113] [099600], approved as compatible in writing by fireproofing manufacturer for each fire-resistance design, SCAQMD VOC compliant, color and sheen as selected by Architect.

PART 3 - EXECUTION - NOT USED

END OF SECTION

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SECTION 078413 - PENETRATION FIRESTOPPING

GUIDELINES

1. Penetration details are shown on drawings, selected as required for construction materials, application and rating.
2. Coordinate selection with required acoustical and visual considerations.
3. Verify field testing requirements by occupancy.
4. Multiple types are specified; select as required by application and coordinate with details shown on drawings.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Penetrations in fire-resistance-rated walls.
 2. Penetrations in horizontal assemblies.
 3. Penetrations in smoke barriers.
 4. Control voltage, communications and electronic safety and security cable penetrations.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Unless otherwise approved, obtain penetration firestopping systems for each kind of penetration firestopping and construction condition indicated through one source from a single manufacturer.
- B. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."
 - 2) Intertek Group in its "Directory of Listed Building Products."
 - 3) FM Approval in its "Approval Guide."

2.3 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
 - 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. Hilti, Inc.
 - b. Specified Technologies, Inc.
 - c. Or Equal
- B. Tested assemblies: As indicated on drawings.
- C. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.
 - 1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
 - 2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
- D. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.
 - 1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
 - 2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
 - a. Those within the cavity of a wall.
 - b. Floor, tub, or shower drains within a concealed space.
 - c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.
 - 3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.
- E. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.
- F. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.
- G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-wool-fiber or rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 - 2. Temporary forming materials.

PENETRATION FIRESTOPPING

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3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.4 FILL MATERIALS

- A. As indicated in listed assemblies shown on drawings.
- B. *Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.*
- C. *Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.*
- D. *Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.*
- E. *Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.*
- F. *Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.*
- G. *Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.*
- H. *Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.*
- I. *Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.*
- J. *Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.*
- K. *Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls to accept standard accessories.*
- L. *Thermal Wrap: Flexible protective wrap tested and listed for up to 2-hour fire ratings in accordance with ASTM E814/UL 1479 for membrane penetrations or ASTM E1725/UL 1724 for thermal barrier and circuit integrity protection.*
- M. *Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.*
- N. *Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.*
- O. *Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.*
- P. *Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.*
- Q. *Firestop Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.*

- R. *Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch diameter.*
- S. *Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.*
- T. *Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.*
- U. *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, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.*
- V. *Putty Pad or Box Insert: Protective materials designed to protect electrical outlet boxes.*
- W. *Firestop Board: Material for large openings to accommodate electrical busways, raceways, cable trays, and multiple copper pipes.*
- X. *Drop-In Device: Pre-formed device with integrated intumescent strips for use with noncombustible and combustible pipes and/or cable bundles.*

2.5 MIXING

- A. *Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.*

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 078443 - JOINT FIRESTOPPING

GUIDELINES

1. Joint firestopping details are shown on drawings, selected as required for construction materials, application and rating.
2. Coordinate selection with required acoustical and visual considerations.
3. Coordinate edge of slab conditions with selected curtain wall systems, including spandrel and connections.
4. Coordinate edge of slab with NFPA 285 assembly conditions.
5. Coordinate field testing based on occupancy.

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated construction and head-of-wall acoustically rated partitions.
2. Wall-to-wall Joints.
3. Wall to Floor Joints
4. Joints at exterior curtainwall/floor intersections.
5. Joints in smoke barriers.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with Listed System Designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."
 - 2) Intertek Group in its "Directory of Building Products."

- B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

- C. Joint Firestopping Systems: Systems that resist spread of fire, the passage of smoke and other gases and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
 - 1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
 - 2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
 - 3. Provide firestop products that do not contain ethylene glycol.
 - 4. Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
 - 5. Structural Movement Requirements: Comply with the California Building Code, Part 1 and 2, Title 24, CCR, including Chapter 16, and as specified.
- D. Water resistance: In addition to fire and smoke ratings, provide fire resistant joints showing no evidence of water leakage at the following locations:
 - 1. Electrical panel, main switch, and meter rooms.
 - 2. Telecommunication and data rooms and closets.
- E. Intumescent Gypsum Wall Framing Gaskets (Applied to Steel Tracks, Runners, and Studs prior to Framing Installation): Provide products with fire, smoke, and acoustical ratings that allow movement up to 100 percent compression and/or extension in accordance with UL 2079 or ASTM E1966; have an L Rating less than 1 cfm/ft. in accordance with UL 2079; and a minimum Sound Transmission Class (STC) rating of 56 in accordance with ASTM E90 or ASTM C919.
- F. For aluminum curtain-wall assemblies with one- or two-piece rectangular mullions at least 2-1/2 by 5 inches, provide perimeter fire-barrier system that does not require direct screw attachment to mullions and transoms to support and fasten curtain-wall insulation. System to be tested in accordance with ASTM E2307 for up to 2-hour fire resistance and with ASTM E1233 for wind cycling equivalent to 108 mph wind for 500 cycles.
- G. Joints in or between Fire-Resistance-Rated Construction and Head-of-Wall Acoustically Rated Partitions: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
 - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
 - 2. Coordinate selection of Head-of-Wall top tracks and accessories with products as specified in Section 092116 "Non-Structural Metal Framing" and Section 092216.23 "Gypsum Board Shaftwall Assemblies."
- H. Joints at Exterior Curtainwall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E2307.
 - 1. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
- I. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg.
 - 1. L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.

2.3 Manufacturers

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. STI
 - b. Hilti
 - c. Rectorseal
 - d. Or equal

- B. Series: As indicated on drawings.

2.4 ACCESSORIES

- A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION - NOT USED

END OF SECTION 078443

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SECTION 079200 - JOINT SEALANTS

GUIDELINES

1. Sealant conditions shall be shown on drawings, selected as required for construction materials and application.
2. Coordinate selection with required acoustical and visual considerations.
3. Security sealants shown for vandalism considerations. Note that these have very limited movement capability.
4. Establish testing requirements, including adhesion, for all conditions and structural silicone loaded conditions.
5. Single component or multi-component sealant selection is typically related to project size and applications, with single component used on small projects. Some multi-component sealants have increased durability characteristics.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Silicone joint sealants.
 2. Non-staining silicone joint sealants.
 3. Urethane joint sealants.
 4. Immersible joint sealants.
 5. Silyl-terminated polyether joint sealants.
 6. Mildew-resistant joint sealants.
 7. Butyl joint sealants.
 8. Latex joint sealants.
 9. Security sealants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified
1. Adhesives, primers and adhesives: Comply with SCAQMD VOC content and VOC emissions regulations.

2.2 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Elastomeric Sealants: Comply with requirements indicated for each liquid-applied sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- C. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

- D. Suitability for Immersion in Liquids. Where elastomeric sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247 and qualify for the length of exposure indicated by reference to ASTM C 920 for Class 2. Liquid used for testing sealants is deionized water, unless otherwise indicated.
- E. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- F. Source Limitations: Obtain each kind of joint sealant from a single source from a single manufacturer.
- G. Colors of Exposed Joint Sealants: **Unless custom color specified, provide color as selected by Architect from manufacturers full range of currently available colors, including colors indicated as special order.**

2.3 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 100/50, NT: Single-component, non-sag, plus 100 percent and minus 50 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. GE Construction Sealants; Momentive Performance Materials Inc.; SCS2700 SilPruf LM.
 - b. Sika Corporation; Joint Sealants; Sikasil WS-290 or Sikasil WS-290 FPS.
- B. Silicone, S, NS, 50, T, NT: Single-component, non-sag, plus 50 percent and minus 50 percent movement capability, traffic- and non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Uses T and NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; DOW CORNING 799 SILICONE GLASS AND METAL BUILDING SEALANT or Dow Corning Contractors Concrete Sealant.
 - b. Soudal USA; RTV 50.

2.4 NON-STAINING SILICONE JOINT SEALANTS

- A. Non-Staining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.
- B. Silicone, Non-Staining, S, NS, 100/50, T, NT: Non-staining, single-component, non-sag, plus 100 percent and minus 50 percent movement capability, traffic- and non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses T and NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; Dow Corning 790 Silicone Building Sealant.

2.5 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, non-sag, non-traffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation; Construction Systems; MasterSeal CR 195 (Pre-2014: Sonolastic Ultra).
 - b. Bostik, Inc; Chem-Calk 2000.

- c. Pecora Corporation; Dynatrol I-XL.
 - d. Sika Corporation; Joint Sealants; Sikaflex Textured Sealant.
 - e. Tremco Incorporated; Dymonic.
- B. Urethane, S, NS, 100/50, T, NT: Single-component, non-sag, plus 100 percent and minus 50 percent movement capability, traffic- and non-traffic-use, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses T and NT.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Sika Corporation; Joint Sealants; Sikaflex 15LM.
- C. Urethane, M, NS, 50, T, NT: Multicomponent, non-sag, plus 50 percent and minus 50 percent movement capability, traffic- and non-traffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, Uses T and NT.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Tremco Incorporated; Dymonic 240.

2.6 IMMERSIBLE JOINT SEALANTS

- A. Urethane, Immersible, S, NS, 50, T, NT, I: Immersible, single-component, non-sag, plus 50 percent and minus 50 percent movement capability, traffic- and non-traffic-use, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Uses T, NT, and I.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Tremco Incorporated; Dymonic 100.

2.7 SILYL-TERMINATED POLYETHER (STPE) JOINT SEALANTS

- A. STPE, S, NS, 50, NT: Single-component, non-sag, plus 50 percent and minus 50 percent movement capability, non-traffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation; Construction Systems; MasterSeal NP 100 (Pre-2014: Sonolastic NP100).
 - b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS7000.
 - c. Pecora Corporation; DynaTrol I-XL Tru-White.
 - d. Sherwin-Williams Company (The); Stampede 100.
 - e. Sika Corporation; Joint Sealants; SikaHyflex-150 LM.
- B. STPE, S, NS, 100/50, T, NT: Single-component, non-sag, plus 100 percent and minus 50 percent movement capability, traffic- and non-traffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 100, Uses T and NT.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Soudal USA; SoudaSeal 150LM.
- C. STPE, S, NS, 50, T, NT: Single-component, non-sag, plus 50 percent and minus 50 percent movement capability, traffic- and non-traffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Uses T and NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Franklin International; Titebond WeatherMaster ULTIMATE MP Sealant.
 - b. Soudal USA; SoudaSeal 50LM.

2.8 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, non-sag, plus 25 percent and minus 25 percent movement capability, non-traffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; DOW CORNING 786 SILICONE SEALANT -.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
 - c. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex Sil 100 WF.
 - d. Soudal USA; RTV GP.
 - e. Tremco Incorporated; Tremsil 200.
- C. STPE, Mildew Resistant, S, NS, 50, NT: Mildew-resistant, single-component, non-sag, plus 50 percent and minus 50 percent movement capability, non-traffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. BASF Corporation; Construction Systems; MasterSeal NP 150 (Pre-2014: Sonolastic 150VLM).

2.9 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bostik, Inc; Chem-Calk 300.
 - b. Pecora Corporation; BC-158.

2.10 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Franklin International; Titebond Painter's Plus Caulk or Titebond UA 920 Sealant.
 - b. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex 600 or Bondaflex Sil-A 700.
 - c. Pecora Corporation; AC-20.
 - d. Sherwin-Williams Company (The); PowerHouse Siliconized Acrylic Latex Sealant.
 - e. Tremco Incorporated; Tremflex 834.

2.11 SECURITY SEALANTS: TAMPER RESISTANT

- A. Purpose: Sealant provides substantial resistance to removal while still provide minimal movement capability. Use to prevent creating a sealant void as means to hide or admit contraband.

- B. Urethane, NS, TG: Two-component, traffic-grade, non-sag, tamper resistant ASTM C920, plus 12.5 percent and minus 12.5 percent movement capability, urethane joint sealant
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sika Corporation; Sikaflex - 11FC
 - b. Pecora DynaFlex,
- C. STPU, S, NS, 12.5: Single-component, non-sag, tamper-resistant, silyl-terminated polyurethane joint sealant; ASTM C920, Type S, Grade NS, Class 12.5.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pecora Corporation; DynaFlex SC.

2.12 SECURITY SEALANTS: TAMPER PROOF

- A. Purpose: Sealant provides extreme resistance to removal with little or no movement capability. Use to prevent creating a sealant void as means to hide or admit contraband.
- B. Epoxy Control Joint Resin: 2-component, non-sag control joint resin sealer and adhesive.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sika Corporation; Sikadur 31.
 - b. Pecora Dynapoxy EP1200.

2.13 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Non-staining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.14 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

2.15 JOINT-SEALANT APPLICATION

- A. Applications: Provide sealants at the following applications and as scheduled.
1. Provide sealants at the following exterior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Joints between metal panels.
 - b. Joints between different materials and metal panels.
 - c. Perimeter joints between materials and frames of doors and windows.
 - d. Control and expansion joints in metal ceilings and other overhead surfaces.
 - e. Other joints as indicated or specified.
 2. Provide traffic-bearing urethane sealants at the following exterior joints in the following horizontal traffic surfaces:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated or specified.
 3. Provide non-sag sealants as specified at interior joints in the following vertical surfaces and horizontal non-traffic surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints at frames of exterior openings where frame abuts drywall, framing and other surfaces.
 - c. Tile control and expansion joints.
 - d. Vertical joints on exposed surfaces of concrete walls and partitions.
 - e. Perimeter joints between interior wall surfaces and frames of interior door frames, windows, cased opening frames and elevator entrances.
 - f. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - g. Joints between acoustical edge angle and adjacent wall surface.
 - h. Joints between top of counter splash, counter intersections with adjacent surfaces and casework edges abutting wall or ceiling surfaces.
 - i. Joints between wall surface and metal trim at integral flooring coved base.
 - j. Joints between floor or wall where rubber coved base terminates at an exposed outside corner.
 - k. Acoustical seal (pads) at non-fire rated penetrations, including electrical junction boxes, thermostat boxes, and similar items.
 - l. Other joints as indicated or specified.
 4. Provide traffic bearing urethane sealant at interior joints in the following horizontal traffic surfaces:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated or specified.
 5. Provide acoustical sealant at non-fire rated assemblies as specified in Section 092900.
 6. Provide security rated sealant at all conditions referred to or indicated as "tamper proof" or "tamper resistant", security sealant, or other terminology at applications as specified.

2.16 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces JS-#.
1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.

- b. Joints between plant-precast architectural concrete paving units.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant - Silicone:
 - a. Single-Component:
 - 1) Non-Sag: Silicone, S, NS, 50, T, NT.
 - 3. Joint Sealant - Urethane:
 - a. Single-Component:
 - 1) Non-Sag: Urethane, S, NS, 100/50, T, NT.
 - 4. Joint Sealant - Silyl-Terminated Polyether (STPE):
 - a. Single Component:
 - 1) Non-Sag: STPE, S, NS, 100/50, T, NT.
 - 5. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces subject to water immersion JS-#.
 - 1. Joint Locations:
 - a. Joints in pedestrian plazas.
 - b. Other joints as indicated on Drawings.
 - 2. Joint Sealant - Urethane:
 - a. Single Component:
 - 1) Non-Sag: Urethane, Immersible, S, NS, 50, T, NT, I.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces JS-#.
 - 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Joints between plant-precast architectural concrete units.
 - c. Control and expansion joints in unit masonry.
 - d. Joints between metal panels.
 - e. Joints between different materials listed above.
 - f. Perimeter joints between materials listed above and frames of doors windows and louvers.
 - g. Other joints as indicated on Drawings.
 - 2. Joint Sealant - Silicone:
 - a. Single Component:
 - 1) Non-Sag: Silicone, S, NS, 100/50, NT.
 - 2) Non-Staining: Silicone, Non-staining, S, NS, 100/50, T, NT.
 - 3. Joint Sealant - Urethane
 - a. Single Component:
 - 1) Non-Sag: Urethane, S, NS, 100/50, T, NT.
 - 4. Joint Sealant - Silyl-Terminated Polyether (STPE):

- a. Single Component:
 - 1) Non-Sag: STPE, S, NS, 100/50, T, NT.
- 5. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in horizontal traffic surfaces JS-#.
 - 1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant - Silicone:
 - a. Single-Component:
 - 3. Non-Sag: Silicone, S, NS, 50, T, NT Joint Sealant - Urethane:
 - a. Single-Component:
 - 1) Non-Sag: Urethane, S, NS, 25, T, NT.
 - 4. Joint Sealant - Silyl-Terminated Polyether (STPE):
 - a. Single Component:
 - 1) Non-Sag: STPE, S, NS, 50, T, NT.
 - 5. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces JS-#.
 - 1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of unit masonry walls and partitions.
 - d. Other joints as indicated on Drawings.
 - 2. Joint Sealant - Silicone:
 - a. Single-Component:
 - 1) Non-Sag: Silicone, S, NS, 50, T, NT.
 - 3. Joint Sealant - Urethane:
 - a. Single-Component:
 - 1) Non-Sag: Urethane, S, NS, 25, NT.
 - 4. Joint Sealant - Silyl-Terminated Polyether (STPE):
 - a. Single Component:
 - 1) Non-Sag: STPE, S, NS, 50, NT.
 - 5. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces not subject to significant movement JS-#.
 - 1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.

- b. Perimeter joints between interior wall surfaces and frames of interior doors windows and.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Acrylic latex.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- G. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal non-traffic surfaces JS-#.
 - 1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT STPE, Mildew Resistant, S, NS, 50, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- H. Joint-Sealant Application: Concealed mastics JS-#.
 - 1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Butyl-rubber based.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- I. Joint-Sealant Application: Security Sealant – Tamper Proof JS-#.
 - 1. Joint Locations:
 - a. Sealant provides extreme resistance to removal with little or no movement capability. Use to prevent creating a sealant void as means to hide or admit contraband.
 - 2. Joint Sealant: STPU, S, NS, 12.5 or Epoxy Control Joint Resin.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- J. Joint-Sealant Application: Tamper Resistant Security Sealant JS-#.
 - 1. Joint Locations:
 - a. Sealant provides substantial resistance to removal while still provide minimal movement capability. Use to prevent creating a sealant void as means to hide or admit contraband.
 - 2. Joint Sealant: Urethane, S, NS, TG.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

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SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

GUIDELINES

1. *Establish fire rated door inspection procedures as required by NFPA 80.*
2. *Use only hot dipped galvanized finish at exterior doors and frames. Evaluate A60 vs A90 based on exposure.*
3. *Specify full profile frame welding for exterior doors. Consider full profile welding vs knock down at all interior door frames for strength and alignment.*
4. *Specify only SDI Model 2 seamless door edges.*
5. *Consider "active shooter" potential and use of appropriately ballistic rated glass and frames. Review updated UL 752 and recently issued ASTM F3561.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
1. Interior standard steel doors and frames.
 2. Exterior standard steel doors and frames.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Curries Company; ASSA ABLOY.
 2. Steelcraft; Allegion
 3. DHI
- B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer regularly engaged in the manufacture of hollow metal doors and frames for not less than 5 years.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.
- B. Sound Rating: Where acoustic criteria are indicated on drawings, provide sound-control (acoustical) door assemblies that have been fabricated and tested as sound-retardant units, are identical to assemblies tested according to ASTM E 90 by an independent testing agency and have the indicated certified STC rating according to ASTM E 413.
- C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.10 deg Btu/F x h x sq. ft. when tested in accordance with ASTM C1363 or ASTM E1423.
- D. Air Infiltration: Provide entrance door assemblies with maximum air infiltration of 0.3 cfm/sq. ft. of door area for single doors and 1.0 cfm /sq. ft for double doors when tested according to ASTM E 283 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft.

2.3 INTERIOR DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Standard Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.
 - 1. Application: All applications unless noted otherwise.
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (18 gage).
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: Bevel lock and hinge edges 1/8 inch in 2 inches .
 - f. Core: Polyisocyanurate.
 - g. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated and temperature-rise-rated doors.
 - 3. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (16 gage).
 - b. Sidelite Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: [Knocked down] [Slip-on drywall][Full profile welded.]
 - 4. Exposed Finish: Primer compatible with finish system specified in Division 09 painting sections.
- C. Standard Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.
 - 1. Application
 - a. Lab, research rooms and lab support spaces
 - b. Janitor, service and utility rooms.
 - c. Public Toilet Rooms, Multiple accommodation toilet rooms, staff locker rooms
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: **Metallic-coated** steel sheet, minimum thickness of 0.053 inch (16 gage).
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: **Bevel lock and hinge edges** 1/8 inch in 2 inches.
 - f. Core: **Polyisocyanurate**.
 - g. Fire-Rated Core: Manufacturer's standard **laminated mineral board** core for fire-rated **and temperature-rise-rated** doors.
 - 3. Frames:
 - a. Materials: **Metallic-coated** steel sheet, minimum thickness of 0.053 inch.(16 gage)
 - b. **Sidelite Transom** Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: **Full profile welded**.
 - 4. Exposed Finish: Primer compatible with finish system specified in Division 09 painting sections.

2.4 EXTERIOR DOORS AND FRAMES

- A. Standard Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.
 - 1. Application
 - a. All exterior doors and frames.
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: **Metallic-coated** steel sheet, minimum thickness of 0.053 inch.
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: **Bevel lock and hinge edges** 1/8 inch in 2 inches.
 - f. Core: **Polyisocyanurate**.
 - g. Fire-Rated Core: Manufacturer's standard **laminated mineral board** core for fire-rated **and temperature-rise-rated** doors.
 - 3. Frames:
 - a. Materials: **Metallic-coated** steel sheet, minimum thickness of 0.053 inch.
 - b. **Sidelite Transom** Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: **Full profile welded**.
 - 4. Exposed Finish: Galvanized, minimum [A60][A90] coating.

2.5 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than **25** percent.
- B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- E. Inserts, Bolts, and Fasteners: Hot dip galvanized in accordance with ASTM A153/A153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- H. Glazing: Comply with requirements in Section 088000 "Glazing."

2.6 STEEL FINISHES

- A. Metallic Coated steel sheet: ASTM A653, [A60][A90] Galvannealed.
 - 1. Where specified, provide shop primer over metallic coating.
- B. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

HOLLOW METAL DOORS AND FRAMES

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2. Shop primer is in addition to finish painting systems, including primers, specified in "Section 099123 "Interior Painting," Section 099113, "Exterior Painting", and Section 099600 "High-Performance Coatings at locations as specified and defined on drawings

2.7 ACCESSORIES

- A. Louvers: Provide louvers for interior doors, where indicated, which comply with SDI 111, with blades or baffles formed of 0.020-inch thick, cold-rolled steel sheet set into 0.032-inch- thick steel frame.
 1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
 2. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

2.8 LITE OPENING FRAMES

- 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. Anemostat Products; a Mestek company, or equal
- B. Series: Lo-Pro Metal Vision Frame, 0.048-inch- thick, cold-rolled steel sheet; factory primed for paint.
 1. Provide UL or WHI listed frames approved for use in doors of fire-protection rating indicated on Drawings.
 2. Provide lead lined frames at doors with lead lining.

2.9 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
 1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
 2. Fire Door Cores: As required to provide fire-protection and temperature-rise ratings indicated.
 3. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches.
 4. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
 5. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
 6. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 7. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

- C. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
 4. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.
 - 4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
 - b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - c. Post-Installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
 5. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
 6. Terminated Stops (Hospital Stops): Terminate stops 6 inches above finish floor with a 45-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
1. Review hardware specified in other Sections, including 087100. Provide all reinforcement and backing as required by hardware manufacturer.
 2. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 3. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

4. Provide minimum 12-gauge (0.11 inch) steel sheet, secured by a minimum of 6 spot welds for door and frame hardware reinforcement.
 - a. Butt Hinges: Provide steel plate 3/16 inch thick by 1-1/2 inches wide by 6 inches longer than hinge. Secure by not less than 6 spot welds.
 - b. Provide reinforcement at doors and frames on both sides for closers, whether or not closers are specified.
 5. In accordance with NFPA 80, Section 4.1.3, field modifications of mortised and electric hardware not acceptable.
 6. Provide door hardware preparation and location in compliance with applicable requirements of Texas Accessibility Standard.
- F. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
 2. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
 3. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 4. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
 5. Provide loose stops and moldings on inside of hollow-metal work.
 6. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 7. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 081416 - FLUSH WOOD DOORS

GUIDELINES

1. *Establish fire rated door inspection procedures as required by NFPA 80.*
2. *Use only factory finished doors unless repair of existing doors.*
3. *Require sample, finished in selected finish. Confirm manufacturers finish system is acceptable.*
4. *Require 12 inch square full thick corner door assembly, showing final finish, edge veneer, and door core construction.*
5. *Consider "active shooter" potential and use of appropriately ballistic rated doors, glass and frames. Review updated UL 752 and recently issued ASTM F3561.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Five-ply flush wood veneer-faced doors and transom panels for transparent finish.
 2. Factory finishing flush wood doors.
 3. Factory fitting flush wood doors to frames and factory machining for hardware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure in accordance with UL 10C.
 1. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.3 FLUSH WOOD DOORS, GENERAL

1. Provide labels and certificates from AWI certification program indicating that doors comply with requirements of grades specified.
 - a. Contractor registers the Work under this Section with the AWI Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.
 2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.
- B. Certified Wood: Wood doors shall contain not less than 60 percent certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."

- C. Adhesives: Do not use adhesives that contain urea formaldehyde.
- D. Composite Wood Products: Products shall be made without urea formaldehyde.

2.4 SOLID-CORE FLUSH WOOD VENEER-FACED DOORS AND TRANSOM PANELS - TRANSPARENT FINISH

A. Interior Solid-Core Doors, Solid-Core Five-Ply:

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. VT Industries Inc.
 - b. Or equal.
2. Performance Grade:
 - a. ANSI/WDMA I.S. 1A Extra Heavy Duty.
3. ANSI/WDMA I.S. 1A Grade: Premium.
4. Faces: Single-plywood veneer not less than 1/50 inch thick.
 - a. Species: Hard White Maple.
 - b. Cut: [rotary/flat][quarter].
 - c. Grain Orientation: Vertical
 - d. Match between Veneer Leaves: Book match.
 - e. Assembly of Veneer Leaves on Door Faces: Center-balance match.
 - f. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 - g. Room Match: Well matched for color and grain within each separate room or area of building. Corridor-door faces shall be compatible for color and grain where they are separated by 20 feet or more.
 - h. Transom Match: End match.
5. Exposed Vertical and Top Edges: Any closed-grain hardwood.
 - a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: 550 lbf in accordance with WDMA T.M. 10.
6. Core for Non-Fire-Rated Doors:
 - a. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Door Face: 550 lbf.
 - 2) Screw Withdrawal, Vertical Door Edge: 550 lbf.

7. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
 - 1) Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware. 5-inch top-rail blocking.
 - 2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - 3) 5-inch midrail blocking, in doors indicated to have armor plates.
 - 4) 5-inch midrail blocking, in doors indicated to have exit devices.
8. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.5 LITE OPENING FRAMES

- 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. Anemostat Products; a Mestek company, or equal
- B. Series: Lo-Pro Metal Vision Frame, 0.048-inch- thick, cold-rolled steel sheet; factory primed for paint.
 1. Provide UL or WHI listed frames approved for use in doors of fire-protection rating indicated on Drawings.
 2. Provide lead lined frames at doors with lead lining.
- C. Glazing: As indicated in Door Schedule and specified in Section 088000.

2.6 LOUVERS

- A. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated on Drawings.
- B. Metal Louvers:
 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. Anemostat Products; a Mestek company.
 2. Blade Type: Vision-proof, inverted V.
 3. Metal and Finish: Hot-dip galvanized steel, 0.040 inch thick, with baked-enamel- or powder-coated finish.

2.7 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
 1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 2. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied, including drilling pilot holes for hinge screws and lock fronts.
 1. Locate hardware to comply with DHI-WDHS-3.
 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.

FLUSH WOOD DOORS

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3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
6. Factory prepare doors receiving templated mortised and electric hardware in accordance with Door Hardware Schedule. Field modification of mortised and electric hardware not acceptable in accordance with NFPA 80, Section 4.1.3.

C. Transom and Side Panels:

1. Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors.
2. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
3. Fabricate door and transom panels with full-width, solid-lumber, rabbeted, meeting rails.
4. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

D. Openings: Factory cut and trim openings through doors.

1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
3. Louvers: Factory install louvers in prepared openings.

2.8 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.

1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
2. Finish faces, all four edges, edges of cutouts, and mortises.
3. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises, unless top of door is visible in finished project.

B. Factory finish doors.

C. Transparent Finish:

1. Architectural Woodwork Standards Grade: Premium.
2. Finish: Architectural Woodwork Standards System-11, Polyurethane, Catalyzed.
3. Staining: As selected by Architect from manufacturer's full range.
4. Sheen: Satin.

PART 3 - EXECUTION – NOT USED

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

GUIDELINES

1. *Schedule access door type.*
2. *Locate fire rated doors.*
3. *Specify District locking and latching criteria for each application.*
4. *Note access panel labeling at suspended ceilings regarding access. Verify size and location of access doors provides adequate reach to the system component. Engineer ceiling system for live loads when required.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Access Panel Criteria: Unless otherwise indicated, provide access panels sized as follows:
1. Use 12-inch x 12-inch access panels at locations where wall and above ceiling MEP valve, device or other items requiring access is not greater than 2-foot distance from the access panel.
 2. Use 24-inch x 24-inch access panels at locations where wall and above ceiling MEP valve, device or other items requiring access is greater than 2 feet but less than 4 foot - 9 inches distance from the access panel.
 3. Provide access panel dimensions as required where wall and above ceiling MEP valve, device or other items requiring access is greater than 4 foot – 9-inch distance from the access panel.
- B. The Contractor shall coordinate all wall and above ceiling elements with the location of access panels to assure proper and adequate access. If obstructions to the above ceiling devices, valves, and similar components are unavoidable, larger size access panels shall be installed than normally required or specified.
- C. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection **and temperature-rise limit** ratings indicated, according to NFPA 252 or UL 10B.
- D. Ceiling Access Panel Labeling at suspended ceilings of all types:
1. Provide permanent label at ceiling access panels in excess of 16 inches square, or of such size to allow an individual to access the ceiling framing or cavity beyond the access panel.
 2. Provide label made of laminated plastic, heavy duty vinyl, or similar material, adhesive attached to concealed side of access panel. Label shall be shop fabricated with preprinted message, minimum 1/2-inch-high font, Helvetica all caps font, black lettering on white background. Handwritten label is not acceptable. Position label so that it is immediately visible when panel is opened.
 3. Provide permanent message as follows: CAUTION! CEILING IS NOT DESIGNED TO SUPPORT THE WEIGHT OF A PERSON OR MATERIALS. DO NOT STAND, WALK OR CRAWL ON CEILING, OR USE CEILING FOR STORAGE OF ANY KIND.

2.2 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Exposed Flanges :

1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
 - a. Karp Associates, Inc.
 - b. Nystrom, Inc.
 - c. Williams Bros. Corporation of America (The).
2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
3. Locations: **Wall and ceiling.**
4. Metallic-Coated Steel Sheet for Door: **Nominal 0.064 inch, 16 gage, factory primed.**
5. Frame Material: **Same material, thickness, and finish as door.**
6. Latch and Lock: **Cam latch, key operated.**

B. Flush Access Doors with Concealed Flanges :

1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
 - a. Karp Associates, Inc.
 - b. Nystrom, Inc.
 - c. Williams Bros. Corporation of America (The).
2. Description: Face of door flush with frame; with concealed flange for **gypsum board** installation and concealed hinge.
3. Locations: **Wall and ceiling.**
4. Metallic-Coated Steel Sheet for Door: **Nominal 0.064 inch, 16 gage factory primed.**
5. Frame Material: **Same material and thickness as door.**
6. Latch and Lock: **Cam latch, key operated.**

C. Exterior Flush Access Doors :

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. Karp Associates, Inc.
2. Description: Weatherproof assembly, with face of door fit flush with frame and with exposed frame. Include extruded door gaskets and minimum 2-inch-thick fiberglass insulation.
3. Locations: **[Wall] <Insert location or substrate>.**
4. Stainless Steel Sheet for Door: **Nominal 0.062 inch, 16 gage, ASTM A480/A480M No. 4 finish.**
5. Frame Material: **Same material, thickness, and finish as door.**
6. Latch and Lock: **Cam latch operated by handle, with separate mortise lock; with interior release.**

D. Interior Flush GFRG Access Doors with Concealed Flanges :

1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
 - a. Karp Associates, Inc.
 - b. Williams Bros. Corporation of America (The).

2. Description: Face of **drop-in** door flush with frame, with concealed flange for gypsum board installation.
 3. Locations: **Ceiling**.
 4. Door Type: **Drop in, radius corner** Door and Frame Material: Unpainted glass-fiber-reinforced gypsum, with frames reinforced for hardware and fastenings.
 5. Recessed Basis of Design Series: AHA-GYP, unless otherwise specified, at gypsum conference rooms, entry lobby, public corridors, lounges and similar areas.
 6. Frame: Minimum 0.060-inch- thick sheet metal with drywall bead.
- E. Lock: Key-operated cylinder cam latch lock with mortise cylinder, specified in Division 8 Finish: Manufacturers white powder primer at frame. Provide 5/8-inch gypsum board Flush, exposed flange, Non-Rated Ceiling Access Doors – Medium and High-Risk Level:
1. at non-rated assemblies.
 2. Frame: Minimum 0.060-inch- thick sheet metal (16 Gage).
 3. Automatic Closer: Spring type.
 4. Lock: Tool key operated, self-latching, with interior release.
 - a. Provide stainless steel, Type 304, No. 4 finish frame and door at high humidity areas.
- F. Aluminum sheet rated assemblies. Fabricated from aluminum unless specified otherwise. Metal with a minimum thickness of 0.064 inch.
1. Hinges: Continuous piano hinge.
 2. Lock: Key-operated lock with mortise cylinder, specified in Division 8 Section "Door Finish: Unless indicated otherwise, manufacturers white powder primer

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

- A. Fire-Rated, Flush Access Doors with Exposed Flanges :
1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
 - a. Karp Associates, Inc.
 - b. Nystrom, Inc.
 - c. Williams Bros. Corporation of America (The).
 2. Description: Door face flush with frame, **with a core of mineral-fiber insulation enclosed in sheet metal**; with exposed flange, self-closing door, and concealed hinge.
 3. Locations: **Wall and ceiling**.
 4. Door Size: **Insert door size**.
 5. Fire-Resistance Rating: Not less than **that of adjacent construction**.
 6. Temperature-Rise Rating: 250 deg F at the end of 30 minutes.
 7. Metallic-Coated Steel Sheet for Door: , factory **primed**.
 8. Frame Material: **Same material, thickness, and finish as door**.
 9. Latch and Lock: Self-latching door hardware, **prepared for mortise cylinder**.
- B. Fire-Rated, Flush Access Doors with Concealed Flanges :
1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
 - a. Karp Associates, Inc.
 - b. Nystrom, Inc.
 - c. Williams Bros. Corporation of America (The).

2. Description: Door face flush with frame, **with a core of mineral-fiber insulation enclosed in sheet metal**; with concealed flange for **gypsum board** installation, self-closing door, and concealed hinge.
3. Locations: **Wall and ceiling**.
4. Door Size: **<Insert door size>**.
5. Fire-Resistance Rating: Not less than **that of adjacent construction**.
6. Temperature-Rise Rating: 250 deg F at the end of 30 minutes.
7. Metallic-Coated Steel Sheet for Door: , factory **primed**.
8. Frame Material: **Same material, thickness, and finish as door**.
9. Latch and Lock: Self-closing, self-latching door hardware, **prepared for mortise cylinder**.

2.4 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- C. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, **Type 304**. Remove tool and die marks and stretch lines, or blend into finish.
- D. Stainless Steel Flat Bars: ASTM A666, **Type 304**. Remove tool and die marks and stretch lines, or blend into finish.
- E. Aluminum Sheet: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- F. Frame Anchors: Same material as door face.
- G. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.
- H. Tamper Resistant Fasteners and anchors: At Vandal Resistant Applications.
 1. Provide Bryce Security Fasteners, Penta-Plus design, head, thread and size as required by condition. Provide Raptor head where washer otherwise used.
 2. Register and deliver all installation tools to Owner when work is complete.

2.5 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
 2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.

- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.
 - 1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.
- E. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.
 - 3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in **Section 087100 "Door Hardware."**
- F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION - NOT USED

END OF SECTION

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SECTION 083313 - COILING COUNTER DOORS

GUIDELINES

1. *Motorized units are specified for safety and injury user risk. Confirm with District.*
2. *Verify fire rated counter door operation and coordination with alarm system.*
3. *Note fire rated counter at fire rated counter doors. Avoid substitution of non-rated materials.*
4. *Verify selected counter door provides required STC value. Coordinate finishes.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Counter door assemblies, motorized.
 2. Fire-rated counter door assemblies, motorized.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain coiling counter doors from single source from single manufacturer.
1. Obtain operators and controls from coiling counter door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Complying with NFPA 80; listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 or UL 10B.
1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 2. Temperature-Rise Limit: At exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
 3. Smoke Control: In corridors and smoke barriers, provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. of door opening at 0.10 inch wig for both ambient and elevated temperature tests.
- B. Sound-Control Doors: Assemblies tested in a laboratory for sound-transmission-loss performance according to ASTM E90, calculated according to ASTM E413, and rated for not less than the STC value indicated.

2.3 COUNTER DOOR ASSEMBLY

- A. Counter Door: Coiling counter door formed with curtain of interlocking metal slats.
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. Cornell; a Cornell Cookson company.

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- b. Overhead
 - c. or equal
- B. Operation Cycles: Door components and operators capable of operating for not less than 50,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
 - 1. Include a tamperproof cycle counter.
- C. Door Curtain Material: [Galvanized steel] [Stainless steel][Aluminum.]
- D. Door Curtain Insulation at acoustical condition: [R = 2.0]
- E. Door Curtain Slats: Flat profile slats of 1-1/2-inch Insert dimension center-to-center height.
 - 1. Gasket Seal. Manufacturer's standard continuous gaskets between slats.
 - 2. Provide manufacturers PVC back slat at acoustical condiditions.
- F. [Acoustical Value: Sound Transmission Class 26 STC]
- G. Bottom Bar: Manufacturer's standard continuous channel or tubular shape fabricated stainless steel aluminum extrusion and finished to match door.
- H. Curtain Jamb Guides: [Stainless steel][Aluminum] with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.
- I. Hood: Match curtain material and finish.
 - 1. Shape: As indicated on Drawings.
 - 2. Mounting: Face of wall.
- J. Sill Configuration: No sill Integral metal sill.
- K. Locking Devices: Equip door with locking device assembly.
 - 1. Locking Device Assembly: locking bars, operable from inside and outside with cylinders.
- L. Electric Door Operator:
 - 1. Usage Classification: Heavy duty, 25 or more cycles per hour and more than 90 cycles per day.
 - 2. Operator Location: Wall As indicated on Drawings.
 - 3. Motor Exposure: Interior.
 - 4. Motor Electrical Characteristics:
 - a. Horsepower: 1/2 Insert value hp.
 - b. Voltage:
 - 1) 115-V ac 208-V ac, single phase, 60 Hz.
 - 5. Emergency Manual Operation: Push-up type.
 - 6. Obstruction-Detection Device: Automatic electric sensor edge on bottom bar.
 - a. Sensor Edge Bulb Color: As selected by Architect from manufacturer's full range.
 - 7. Control Station(s): Where indicated on Drawings.
 - 8. Other Equipment: <Insert device>.
- M. Curtain Accessories: Equip door with weather seals.

2.4 FIRE-RATED COUNTER DOOR ASSEMBLY

- A. Fire-Rated Counter Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.
 - 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. Cornell; a Cornell Cookson company.
 - b. Overhead door.
- B. Operation Cycles: Door components and operators capable of operating for not less than 50,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
 - 1. Include a tamperproof cycle counter.
- C. Fire Rating: 1-1/2 hours with smoke control.
- D. Door Curtain Material: [Galvanized][Stainless] steel.
- E. Door Curtain Slats: Flat profile slats of 1-1/2-inch center-to-center height.
 - 1. Insulated-Slat Interior Facing: Metal.
- F. Acoustical:
- G. Curtain Jamb Guides: Stainless steel with exposed finish matching curtain slats.
- H. Hood: Match curtain material and finish.
 - 1. Shape: As indicated on Drawings.
 - 2. Mounting: Face of wall.
- I. Sill Configuration:
 - 1. [Stainless steel sill, UL Listed] .
 - 2. [High-Pressure Decorative Laminate, UL Listed, Color, pattern, and finish as selected by Architect from manufacturer's full range.
- J. Locking Devices: Equip door with locking device assembly.
 - 1. Locking Device Assembly: locking bars, operable from outside with cylinder Insert requirement.
- K. Electric Door Operator:
 - 1. Usage Classification: Heavy duty, 25 or more cycles per hour and more than 90 cycles per day.
 - 2. Operator Location: Wall As indicated on Drawings.
 - 3. Motor Exposure: Interior.
 - 4. Motor Electrical Characteristics:
 - a. Horsepower: 1/2 Insert value hp.
 - b. Voltage:
 - 1) 115-V ac 208-V ac, single phase, 60 Hz.
 - 5. Emergency Manual Operation: Push-up type.
 - 6. Obstruction-Detection Device: Automatic electric sensor edge on bottom bar Insert type.
 - a. Sensor Edge Bulb Color: As selected by Architect from manufacturer's full range.
 - 7. Control Station(s): Where indicated on Drawings Insert location.
 - 8. Other Equipment: <Insert device>.

COILING COUNTER DOORS

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L. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
2. Stainless Steel Finish: ASTM A480/A480M No. 2B (bright, cold rolled) ASTM A480/A480M No. 4 (polished directional satin).
3. Interior Curtain-Slat Facing: [Match finish of exterior curtain-slat face].

2.5 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 DOOR CURTAIN MATERIALS AND FABRICATION

- A. Door Curtains: Fabricate coiling counter door curtain of interlocking metal slats in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A653/A653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch; and as required.
 2. Stainless Steel Door Curtain Slats: ASTM A240/A240M or ASTM A666, Type 304; sheet thickness of 0.025 inch; and as required.
 3. Aluminum Door Curtain Slats: ASTM B209 sheet or ASTM B221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch; and as required.
 4. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face.
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.7 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
1. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.

2.8 LOCKING DEVICES

- A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
1. Lock Cylinders: As specified in Section 087100 "Door Hardware".
 2. Keys: Three for each cylinder.
- B. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.9 CURTAIN ACCESSORIES

- A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for smoke and draft control as required for door listing and labeling by a qualified testing agency.
- B. Weather seals: Equip door with weather-stripping gaskets fitted to entire perimeter of door for air-resistant installation unless otherwise indicated.
 - 1. At door head, use 1/8-inch- thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
 - 2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- thick seals of flexible vinyl, rubber, or neoprene.
- C. <Insert requirements>.

2.10 COUNTER DOOR ACCESSORIES

- A. Metal Sill - Non-rated: Fabricate sills of Type 304 stainless steel in manufacturer's standard thickness with ASTM A480/A480M No. 4 finish.
- B. Metal Sill - Fire rated: Fabricate of Type 304 stainless steel in manufacturer's standard thickness with ASTM A480/A480M No. 4 finish, UL or ITS tested and labeled for 1-1/2-hour fire rating for approved use with fire-door assembly.
- C. Fire-Rated, Laminate Counter: Fire-door manufacturer's high-pressure, decorative laminate-covered countertop; UL or ITS tested and labeled for 1-1/2-hour fire rating for approved use with fire-door assembly.
- D. <Insert requirements>.

2.11 COUNTERBALANCE MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless welded carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
 - 1. Fire-Rated Doors: Equip with auxiliary counterbalance spring and prevent tension release from main counterbalance spring when automatic closing device operates.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.12 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Door Operator Location(s): Operator location indicated for each door.
 - 1. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
- D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated for each door assembly.
 - 1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 - 2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 - 3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
- E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
- F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. [For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.][For fire-rated doors, activation delays closing.]
 - 1. Electric Sensor Edge: Automatic safety sensor edge, located within astragal mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Self-Monitoring Type: Four-wire-configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.
- G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
 - 1. Type: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
- H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 30 lbf. Insert value.

- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. <Insert requirements>.

2.13 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.14 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
- B. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.15 STEEL AND GALVANIZED-STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
- B. <Insert requirements>.

2.16 STAINLESS STEEL FINISHES

- A. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Directional Satin Finish: ASTM A480/A480M No. 4.
- B. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 - EXECUTION - NOT USED

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SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

GUIDELINES

1. *Comply with DSA Delegated Design/Deferred approval requirements. Prepare project specific DSA procedures.*
2. *System based on 4 sided captured system. Note that 4 sided structural silicone glazed systems will likely require a project specific mock up for lab testing. Note that 2 sided SSG acceptable with compliance with CBC Chapter 24 Section 2410 engineering criteria and DSA approval. Window wall systems may be used instead of storefront systems to provide enhanced performance values. Select system accordingly.*
3. *Verify performance values with selected system. Coordinate with BECx procedures.*
4. *High performance two coat fluoropolymer finish included. Adjust if 3 coat or specialty finish selected. Coordinate final selection with District color standards.*
5. *Consider drift joint location and dimension early in design process in consultation with SEOR.*
6. *Consider "active shooter" potential and use of appropriately ballistic rated glass and frames. Review updated UL 752 and recently issued ASTM F3561.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Aluminum-framed storefront systems.
 2. Aluminum-framed entrance door systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design and Deferred Approval: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts. Comply with Section 013575 "Delegated Design Procedures" and DSA procedures.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 2. Dimensional tolerances of building frame and other adjacent construction.
 3. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.

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- C. Structural Loads:
 - 1. Wind Loads: As indicated on Structural Drawings.
 - 2. Other Design Loads: **As indicated on Drawings.**
- D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to **L/175 of clear span for spans of up to 13 feet 6 inches and to L/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.**
 - 2. Deflection Parallel to Glazing Plane: Limited to **[amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch and clearance between members and operable units directly below them to less than 1/16 inch] <Insert deflection limit>.**
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 - 3. Cantilever Deflection: Limited to 2L/175 at unsupported cantilevers.
- E. Structural: Test in accordance with ASTM E330/E330M as follows:
 - 1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
 - 2. When tested at **150** percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding **0.2** percent of span.
 - 3. Test Durations: As required by design wind velocity, but not less than **10** seconds.
- F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
 - 1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lb./sq. ft..
- G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:
 - 1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than [6.24 lb./sq. ft.] [10 lb./sq. ft.] [15 lb./sq. ft.] **<Insert value>.**
 - 2. Maximum Water Leakage: **In accordance with AAMA 501.1.** Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- H. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7] <Insert requirement>.**
 - 1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.6 at design displacement **[and 1.5 times the design displacement].**
- I. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
 - 1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than [0.41 Btu/sq. ft. x h x deg F] [0.45 Btu/sq. ft. x h x deg F] [0.57 Btu/sq. ft. x h x deg F] [0.69 Btu/sq. ft. x h x deg F] **<Insert value>** as determined in accordance with NFRC 100.

- b. Entrance Doors: U-factor of not more than [0.68 Btu/sq. ft. x h x deg F] [0.77 Btu/sq. ft. x h x deg F] [0.83 Btu/sq. ft. x h x deg F] [1.10 Btu/sq. ft. x h x deg F] **<Insert value>** as determined in accordance with NFRC 100.
 - c. Venting Windows: Whole window U-factor of not more than [0.37 Btu/sq. ft. x h x deg F] [0.43 Btu/sq. ft. x h x deg F] [0.45 Btu/sq. ft. x h x deg F] [0.60 Btu/sq. ft. x h x deg F] [0.65 Btu/sq. ft. x h x deg F] **<Insert value>** as determined in accordance with NFRC 100.
- 2. Solar Heat-Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than **[0.26] [0.35] [0.40] [0.45] <Insert value>** as determined in accordance with NFRC 200.
 - b. Entrance Doors: SHGC of not more than **[0.22] [0.25] [0.35] [0.40] [0.45] <Insert value>** as determined in accordance with NFRC 200.
 - c. Venting Windows: Whole window SHGC of not more than **[0.22] [0.27] [0.30] [0.40] <Insert value>** as determined in accordance with NFRC 200.
- 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lb./sq. ft. when tested in accordance with ASTM E283.
 - b. Entrance Doors:
 - 1) Pair of Doors: Air leakage of not more than [1.0 cfm/sq. ft.] **<Insert value>** at a static-air-pressure differential of 1.57 lb./sq. ft..
 - 2) Single Doors: Maximum air leakage of [0.5 cfm/sq. ft.] **<Insert value>** at a static-air-pressure differential of 1.57 lb./sq. ft..
 - c. Venting Windows: Whole window air leakage of not more than [0.3 cfm/sq. ft.] **<Insert value>** at a static-air-pressure differential of [6.24 lb./sq. ft.] **<Insert value>** when tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
- 4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than **[35] [55] [70] <Insert value>** as determined in accordance with AAMA 1503.
 - b. Entrance Doors: CRF of not less than **[57] [63] [68] <Insert value>** as determined in accordance with AAMA 1503.
 - c. Venting Windows: Whole window CRF of not less than **[45] [52] [55] <Insert value>** as determined in accordance with AAMA 1503.
- J. Thermal Performance: Provide aluminum-framed entrance and storefront assembly complying with the following characteristics and requirements:
 - 1. Maximum U-factor of 0.57 for fixed components and 0.67 for operable components as determined in accordance with NFRC 100 by a laboratory accredited by a national recognized accreditation organization such as the National Fenestration Rating Council (NFRC) labeled and certified by the manufacturer.
 - a. U-factors from 8.1 of ASHRAE IESHA Standard 90.1-199 are an acceptable alternate for determining compliance with the U-factor criteria. Where credit is taken for a low-emissivity coating, determine the coating's emissivity in accordance with NFRC 301 and provide verification and certification of emissivity from the entrance and storefront assembly manufacturer.

2. Maximum assembly solar heat gain coefficient (SHGC) of 0.49 for north orientation and 0.39 for all other orientations for overall glazed area as determined in accordance with NFRC 200 by a laboratory accredited by a nationally recognized accreditation organization such as the National Fenestration Rating Council (NFRC) and labeled and certified by the aluminum entrance and storefront assembly manufacturer.
 - a. Shading coefficient of the center of glass multiplied by 0.86 is an acceptable alternate method for determining compliance with SHGC requirement for overall glazed area. Provide shading coefficient determined using special data file determined in accordance with NFRC 300 and verified and certified by the glass unit manufacturer.
- K. Sound Transmission: Provide aluminum-framed systems with fixed glazing and framing areas having the following sound-transmission characteristics:
 1. Sound Transmission Class (STC): Minimum [26] [30] [35] <Insert rating> STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
- L. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows.
 1. Outdoor-Indoor Transmission Class: Minimum [26] [30] [34] <Insert number>.
- M. Ballistics Resistance, UL 752: [Listed and labeled as] [Level 1] [Level 2] [Level 3] [Level 4] [Level 5] [Level 6] [Level 7] [Level 8] [Level 9] [Level 10] [Level 1-SG] [Level 2-SG] [Level 3-SG] [Level 4-SG] [Level 5-SG] [Level 6-SG] [Level 7-SG] [Level 8-SG] [Level 9-SG] [Level 10-SG] when tested in accordance with UL 752.
- N. Ballistics Resistance, ASTM F1233: [Class/Level HG1] [Class/Level HG2] [Class/Level HG3] [Class/Level HG4] [Class/Level SMG] [Class/Level R1] [Class/Level R2] [Class/Level R3] [Class/Level R4-AP] [Class/Level R5] [Class/Level SH1] [Class/Level SH2] when tested in accordance with ASTM F1233.
- O. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of [180 deg F] <Insert temperature>.
 - b. Low Exterior Ambient-Air Temperature: [0 deg F] <Insert temperature>.
 - c. Interior Ambient-Air Temperature: [75 deg F] <Insert temperature>.
- P. Structural-Sealant Joints: Designed to produce tensile or shear stress of less than 20 psi.
- Q. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed, aluminum-framed entrances and storefronts without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
 1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

- R. Accessible Entrances:
 - 1. Comply with applicable provisions in **the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and CBC Chapter 11-B.**

2.3 STOREFRONT 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:**
 - 1. Arcadia, Inc.
 - 2. EFCO Corporation.
 - 3. Kawneer North America, an Arconic company.
 - 4. Oldcastle Building Envelope (OBE); CRH Americas.
- B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Exterior Framing Construction: **Thermally broken.**
 - 2. Glazing System: **[Retained mechanically with gaskets on four sides] [Retained mechanically with gaskets on two horizontal edges and structural sealant on two vertical edges.]**
 - 3. Glazing Plane: **[As indicated] [Front][Center][Back] [Multiplane] <Insert location>.**
 - 4. Finish: **Clear anodic finish Color anodic finish High-performance organic finish Superior-performance organic finish.**
 - 5. Fabrication Method: Field-fabricated stick system.
 - 6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 7. Steel Reinforcement: As required by manufacturer.
- C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 ENTRANCE DOOR 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:**
 - 1. Arcadia, Inc.
 - 2. EFCO Corporation.
 - 3. Kawneer North America, an Arconic company.
 - 4. Oldcastle Building Envelope (OBE); CRH Americas.
- B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
 - 1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: **High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.**

2. Door Design:
 - a. **Wide stile**; 5-inch **nominal width**.
 - b. Bottom Rail: 10 inch height.
3. Glazing Stops and Gaskets: **Square**, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide non-removable glazing stops on outside of door.
4. Finish: Match adjacent storefront framing finish.

2.5 ENTRANCE DOOR HARDWARE

- A. Provide hardware as specified in Section 087100.

2.6 Entrance Door Hardware: Hardware not specified in this Section is specified in GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type
- D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
- E. Glazing Sealants:
 1. As recommended by manufacturer.
 2. Structural Glazing Sealants: ASTM C1184 chemically curing silicone formulation that is compatible with system components with which it comes in contact; specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in storefront system indicated.
 3. Color: **Black**.
- F. Weather seal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weather seal-sealant, and structural-sealant-glazed storefront manufacturers for this use.
 1. Color: As selected by Architect.

2.7 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- E. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
- F. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM and prepare surfaces in accordance with applicable SSPC standard.

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

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2.8 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, **finished to match framing system.**
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- C. Concealed Flashing: **Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.**
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.
- E. Perimeter Fire-Resistive Joint Systems: For joints between edges of fire-resistance-rated floor assemblies and entrance and storefront framing, provide systems of type and ratings indicated on Drawings and complying with requirements specified in Division 07 Section "Joint Firestopping."
 - 1. Provide integrity ratings equal to, or exceeding, fire-resistance rating of floor or floor/ceiling assembly forming one side of joint and having the required joint width and movement classification and L-rating.

2.9 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from **[exterior] [interior] [interior for vision glass and exterior for spandrel glazing or metal panels]**.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

- F. Storefront Framing: Fabricate components for assembly using **[shear-block system] [screw-spline system] [head-and-sill-receptor system with shear blocks at intermediate horizontal members] <Insert system>**.
- G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
 - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 - 2. At exterior doors, provide weather sweeps applied to door bottoms.
- I. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- J. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.10 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, **AA-M12C22A41, Class I, 0.018 mm** or thicker.
- B. Color Anodic Finish: AAMA 611, **AA-M12C22A42/A44, Class I, 0.018 mm** or thicker.
 - 1. Color: **As selected by Architect from full range of industry colors and color densities.**
- C. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with **AAMA 2605** and containing not less than **70** percent PVDF resin by weight in color coat.
 - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **for seacoast and severe environments.**
 - 2. Color and Gloss: **As selected by Architect from manufacturer's full range.**

2.11 SOURCE QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to evaluate structural-sealant-glazed systems.
- B. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.
- C. Structural-sealant-glazed system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS

GUIDELINES

1. *Comply with DSA Delegated Design/Deferred approval requirements. Prepare project specific DSA procedures.*
2. *System based on 4 sided captured system. Note that 4 sided structural silicone glazed systems will likely require a project specific mock up for lab testing. Note 2 sided SSG acceptable with compliance with CBC Chapter 24 Section 2410 engineering criteria and DSA approval.*
3. *Verify performance values with selected system. Coordinate with BECx procedures.*
4. *High performance two coat fluoropolymer finish included. Adjust if 3 coat or specialty finish selected. Coordinate final selection with District color standards.*
5. *Consider drift joint location and dimension early in design process in consultation with SEOR.*
6. *Consider "active shooter" potential and use of appropriately ballistic rated glass and frames. Review updated UL 752 and recently issued ASTM F3561.*

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 1. Provide thermally broken, unitized curtain wall system, with glazing captured four sides at all horizontal head, sill, and vertical mullions, and including, but not necessarily limited to, the following:
 - a. Curtainwall frame and glazing, including all supports, connections, sealants, fasteners, gaskets, and related components for a complete curtain wall system.
 - b. Curtain wall assemblies used as punched windows within curtain wall.
 - c. All glazing within the curtainwall system.
 - d. All doors entrance framing and door hardware within the curtainwall system.
 - e. All prefinished flashing, interior closures and window sills, and related transitions.
 - f. All sealants, waterproofing membranes, concealed flashings and all other elements required for preventing air and water intrusion to interior of building.
 - g. Prefinished coating system of all curtain wall system components.
 - h. All spandrel insulation and back panel components.
 2. Design and engineering of complete curtain wall system, prepared under Deferred Approval procedures as specified. Contractor responsible for design of the complete curtain wall system, including transitions to adjacent materials and surfaces. When complete, the curtain wall system shall provide a fully code compliant, waterproof enclosure meeting the specified criteria.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: When tested in accordance with cited test procedures, curtain wall shall meet or exceed the following performance criteria, as well as those indicated in the AAMA "Metal Curtainwall Manual", unless otherwise noted, the effects of the following:
 1. Structural loads.
 2. Thermal movements.
 3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 4. Dimensional tolerances of building frame and other adjacent construction.

5. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferred to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - d. Noise or vibration created by wind and thermal and structural movements.
 - e. Loosening or weakening of fasteners, attachments, and other components.
 - f. Sealant failure.
- B. Structural Loads
 1. Wind Loads: As indicated on Drawings.
 - a. Basic Wind speed = As indicated on Structural Drawings
 - b. Exposure: C
 - c. Internal Pressure Coefficient: GC_{pi} = 0.18
 - d. Design Wind Pressure: As calculated based on Chapter 16A and structural information shown on Structural Drawings.
 2. Seismic Loads: Design curtainwall assemblies to comply with:
 - a. ASCE 7, as referenced in the California Building Code.
 - b. 2022 California Building Code, including Chapters 16A and 24.
 - c. Structural movement requirements listed in this Specification Section.
 - d. Component Importance Factor is 1.0.
 - e. Risk Category: II
- C. Structural-Test Performance – Thermal Breaks: Provide glazed aluminum curtain-wall systems with thermal breaks tested according to AAMA TIR A8DSA, including mullion capacity and thermal break material characteristics.
- D. Structural-Test Performance – Uniform Load Structural Test: Provide glazed aluminum curtain-wall systems tested according to ASTM E 330 as follows:
 1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Duration: As required by design wind velocity but not less than 10 seconds.
- E. Structural-Test Performance – Vertical Inter-Story Movement. Provide glazed aluminum curtain-wall systems tested according to ASTM E 330 as follows
 1. No air and water infiltration in excess of primary performance requirements, no breakage, no damage, or disengagement resulting from vertical displacement of the intermediate level support in the plane of the main wall 1/2 inch up and down six complete cycles.
- F. Structural-Test Performance – Elastic Lateral Racking – Parallel to Wall. Provide glazed aluminum curtain-wall systems tested according to ASTM E 330 as follows:
 1. No air and water infiltration in excess of primary performance requirements, no breakage, no damage, or disengagement resulting from lateral displacement of the intermediate level support in the plane of the main wall at +/-0.5 percent of story height for three complete cycles in accord with AAMA 501.4.

- G. Structural-Test Performance – Deflection of Framing Members: Provide glazed aluminum curtain-wall systems tested according to ASTM E 330 as follows:
 - 1. Deflection Normal to Wall Plane: When tested at both positive and negative load of 60 PSF, deflection is limited to $L/175$ of clear span for spans up to 13 feet 6 inches, and to $L/240$ of clear span plus 1/4 inch, for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to $1/360$ of clear span or 1/8 inch, whichever is smaller.
 - 3. Cantilever Deflection: Where framing members overhang an anchor point, limited to 2 times the length of cantilevered member, divided by 175.
- H. Structural-Test Performance – Story Drift: Provide glazed aluminum curtain-wall systems that accommodate design displacement of adjacent stories indicated.
 - 1. Design Displacement: When tested to AAMA 501.4, system design displacement shall not exceed $0.010 \times$ the story height and ultimate displacement of $1.5 \times$ the design displacement, or as indicated on Drawings, whichever is most restrictive.
 - 2. Test Performance: No glass breakage, anchor failures, or structural damage when tested according to AAMA 501.4.
- I. Thermal Movements: Provide glazed aluminum curtain-wall systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Test Performance: No buckling, stress on glass, glazing-edge seal failure, sealant failure, excess stress on curtain-wall framing, anchors and fasteners, or reduction of performance when tested according to AAMA 501.5.
 - a. Test High Exterior Ambient Air Temperature: That which produces an exterior metal surface temperature of plus 180 deg F.
 - b. Test Low Exterior Ambient Air Temperature: 10 deg F.
 - c. Test Interior Ambient Air Temperature: 70 deg F.
- J. Air Infiltration: Provide glazed aluminum curtain-wall systems with maximum air leakage of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft.
 - 1. Entrance Door Assembly: Maximum air leakage 1.0 cfm/sq.ft at static air pressure differential of 1.57 lbf/sq.ft or 0.5 cmf/sq.ft at 1.57 lbs.fq.ft
- K. Water Penetration Under Static Pressure: Provide aluminum glazed curtain-wall systems that do not evidence water penetration when tested according to ASTM E 331 at a minimum differential static pressure of 20 percent of positive design wind load, but not less than 15 lbf/sq. ft.
- L. Water Penetration Under Dynamic Pressure: Provide glazed aluminum curtain-wall systems that do not evidence water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive design wind load, but not less than 15 lbf/sq. ft.
 - 1. Maximum Water Leakage: According to AAMA 501.1. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

M. Condensation and Thermal Resistance

1. Condensation Resistance: Provide glazed aluminum curtain-wall systems with frame condensation-resistance factor (CRF) as required to meet the specified criteria when tested according to AAMA 1503.
 - a. Outdoor winter design condition: Identify value based on CEC 2022 Joint Appendix, 2022 design conditions for project location.
 - b. Outdoor summer design condition: Identify value based on CEC 2022 Joint Appendix, 2022 design conditions for project location.
 - c. Indoor design conditions:
 - 1) Typical building conditions: 70-75 deg F, plus minus 2 degrees; humidity is uncontrolled

N. Average Thermal Conductance – GL-X:

1. Provide curtainwall systems with average U-factor of not more than 0.041 Btu/sq. ft. x h x deg F when tested according to AAMA 1503, with aluminum frame and use of GL-1.
2. Solar Heat Gain Coefficient: Glass and framing areas shall have a solar heat gain coefficient of no greater than 0.22 as determined according to NFRC 200.

O. Average Thermal Conductance – GL-X:

1. Spandrel Panel Assembly: Provide spandrel glass, backpan and insulation assembly providing average ASHRAE CZ3C Curtainwall value of U= 0.28 and requirements of specified perimeter fire-containment systems, with aluminum frame and use of GL-2.

2.2 ALUMINUM CURTAINWALL CW-# CAPTURED 4 SIDES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:
 1. Arcadia - Basis of Design.
 2. Or equal.
- B. Basis of Design Series:
 1. Type 1 –T500 - OPG 1900, captured all 4 sides. Provide aluminum pressure plate.
- C. Configuration:
 1. Vertical Mullion Size: 2-1/4 inch x depth as indicated on drawings and per approved delegated design submittal.
 - a. Provide heavy wall mullion or structural steel inserts as required to maintain mullion depth criteria..
 2. Glazing Plane: Front.
 3. Vision Glazing: Insulating glass as specified in Section 088000 and indicated on Drawings.
 4. Spandrel Panel Assembly:
 - a. Insulating glass as specified in Section 088000 and indicated on drawings.
 - b. Backpan and insulation: Galvanized steel, with mineral wool as required to comply with fire resistive joint assembly design and thermal resistance requirements.
- D. Accessory Components:
 1. Mullion Cap/Pressure Plate Cap:
 - a. Type 1: Provide aluminum cap extrusions in dimensions as indicated on drawings.

2.3 FRAMING SYSTEMS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated. Minimum recycled content: Maximize recycled content as feasible.
 - 1. Sheet and Plate: ASTM B 209.
 - 2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221.
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 - 4. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
 - B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
 - 1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A 611.
 - 3. Hot-Rolled Sheet and Strip: ASTM A 570/A 570M.
 - C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
 - D. Thermal Barrier: Thermal barrier consists of non-metallic separator between the interior and exterior metal members in a typical condition, while maintaining a continuous watertight seal. Thermal barrier assembly shall be tested to the thermal cycling requirements of ASTM E2692 and show no sign of degradation following the test.
 - E. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads.
 - 4. Finish exposed portions to match framing system.
 - 5. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
 - F. Anchors: Three-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete Inserts (where shown): Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
 - G. Concealed Flashing:
 - 1. Type 1: Dead-soft, 0.018-inch- thick stainless steel, ASTM A 240/A 240M, or of type recommended by manufacturer.
 - 2. Type 2: Silicone flashing membrane:
 - a. Provide Tremco ProGlaze ETA silicone sheet flashing, premolded corners and transitions, 0.060 inches thick (at ribs), Class A per ASTM E 84.
 - b. Provide extruded aluminum receptors and adaptors, similar to Tremco TR-15265, and as required to provide waterproof transitions.
- Framing Sealants:
- 3. Manufacturer's standard sealants compliant with South Coast Air Quality Management District (SCAQMD) VOC regulations.
 - 4. All sealants shall comply with applicable provisions of AAMA 800 and Section 079000.

5. Frame joinery sealants shall be suitable for application specified and as tested and approved by curtainwall manufacturer

H. Framing Gaskets: EPDM, silicone, or silicone-compatible rubber.

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Section 088000.

B. Glazing Materials

1. Setting Blocks/Edge Blocking: Provide in sizes and locations recommended by GANA Glazing Manual. Setting blocks used in conjunction with soft-coat low-e glass shall be silicone.
2. Back-bedding tapes, expanded cellular glazing tapes, toe beads, heel beads and cap beads shall meet the requirements of applicable specifications cited in AAMA 800.
3. Glazing gaskets shall be non-shrinking, weather-resistant, and compatible with all materials in contact.
4. Structural silicone sealant, where used, shall meet the requirements of ASTM C 1184.
5. All materials and finishes in contact with structural silicone shall be tested for compatibility and approved by the sealant manufacturer for the intended application.
6. Gaskets in continuous contact with structural silicone shall be extruded silicone or compatible material.

C. Glazing Sealants: As recommended by manufacturer for joint type, and as follows:

1. Weatherseal Sealant: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant (where applicable) and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
 - a. Sealants shall comply with SCAQMD regulations.
 - b. Color: Custom color matching curtainwall. .

2.5 SWING DOOR ENTRANCE ASSEMBLIES

A. Manufacturer: Provided by curtainwall system manufacturer and integrated into framing system.

B. Basis of Design Entrance System: Arcadia Heavy wall Entrance Door system.

1. Door Construction: 1-3/4-inch overall thickness, with minimum 3/16 inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or equivalent tubular tie rod.
2. Door Design: Wide stile; 5 inchnominal width.
 - a. Provide smooth surfaced bottom rail, full width of door, for 10 inches above floor.
3. Framing components, Glazing Stops and Gaskets:
 - a. Provide square, snap-on, extruded-aluminum stops, with non-removable glazing stops on outside of door.
 - b. Provide manufacturers standard preformed gaskets, color black
 - c. Where shown, provide aluminum entrance frame surround, 1-3/4 inch sight line, finish to match curtainwall.
4. Glass Assembly: GL-X as specified in Section 088000.
5. Door Hardware: As specified in Section 087100.
6. Door Finish: Match Curtainwall.
7. Provide complete integration of all electronic controls, security and monitoring systems by use of dedicated conduits within frames and doors as required.

2.6 ACCESSORY MATERIALS

- A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.7 FABRICATION

- A. Form aluminum shapes before finishing.
- B. Fabricate components that, when assembled, have the following characteristics:
 - 1. Sharp profiles, straight and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered. Provide interlocking male/female type vertical mullion "stack" joints at adjacent grid frame members with sharp, well-defined corners and flush sightlines.
 - 3. The curtainwall and window wall system shall be designed to accommodate inter-story vertical movement as shown on structural drawings, including fabrication tolerance, without damage.
 - 4. Place anchor penetrations and framing connection fasteners located inboard of the primary air seal.
 - 5. Glazing pocket at each glass lite shall be compartmentalized.
 - 6. Conceal fasteners at vertical to horizontal main framing connections and at miscellaneous trim except as shown on architectural drawings or otherwise required.
 - 7. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
 - 8. Physical and thermal isolation of glazing from framing members.
 - 9. Accommodations for thermal and mechanical movements of glazing and framing to prevent glazing-to-glazing contact and to maintain required glazing edge clearances.
 - 10. Provisions for reglazing from exterior.
 - 11. Principal extruded framing members shall be a minimum 0.125 inches in thickness.
 - 12. Extruded or formed trim components shall be a minimum 0.060 inches in thickness.
- C. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- D. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
- D. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - 1. Color: As selected by Architect from full range of industry colors and color densities.
- E. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.
 - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
 - 2. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION – NOT USED

END OF SECTION 084413

SECTION 085619 - PASS WINDOWS

GUIDELINES

1. *Verify accessibility reach ranges are met. Consider motorized units.*
2. *Coordinate glass type.*
3. *Pass window is not specified as a security or bullet resistive assembly. Conform requirements with District.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes aluminum pass windows for exterior locations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.2 ALUMINUM PASS WINDOWS

- A. Manufacturer:
 1. CRL or equal.
- B. Operating Types:
 1. Horizontal sliding pass window, top hung, with stainless steel counter shelf.
- C. Series: CRL DW 1800P, finish color to match storefront.
- D. Glazing System: Manufacturers standard glazing system for insulated glass, 5/8 inch thick, glass to match GL-X specified per 088000.
- E. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907 or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.
 1. Exposed Hardware Color and Finish: Match window finish and color.
- F. Horizontal-Sliding Window Hardware:
 1. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. Provide manufacturers standard keyed lock, keyed as directed by Owner.
 2. Roller Assemblies: Low-friction design.
- G. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
- H. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
 1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.3 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Powder Coat Finish: Provide custom powder coat finish complying with AAMA 2604.
 - 1. Color: Match curtainwall.

PART 3 - EXECUTION - NOT USED

END OF SECTION 085619

SECTION 086300 - SKYLIGHTS

GUIDELINES

1. *Comply with DSA Delegated Design/Deferred approval requirements for system and glass thickness. Prepare project specific DSA procedures.*
2. *Provide laminated glass in thickness as appropriate, including impact requirements.*
3. *Specify glass performance values based on energy analysis method and compliance with design and Title 24, Part 6.*
4. *Note recommendation for heat soak procedure for tempered glass. Verify approach with Owner and consider cost and schedule impact.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes skylights with structural framing as specified, including glazing, perimeter trims, accessories, shims and anchors, and perimeter sealing of skylight framing.
- B. Design and engineering of complete skylight system, prepared under Delegated Design procedures as specified. Contractor responsible for design of the complete system, including transitions to adjacent materials and surfaces. When complete, the system shall provide a fully code compliant, waterproof enclosure meeting the specified criteria.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Loads, including wind loads: As indicated on Structural Drawings.
- B. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.
- C. Structural-Test Performance: skylights tested in accordance with ASTM E330, as follows:
 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified deflection limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- D. Fall-Protection Performance: Comply with OSHA testing. Provide test reports documenting:
 1. Installed skylight assemblies with specified glazing are capable of safely supporting the greater of 400 lbs or twice the weight of employees, equipment, and materials that may be imposed on any 1 sq. foot of the assembly at any time.
 2. Installed skylights with specified glazing are capable of withstanding dynamic impact load of 2000 ft-pounds.
- E. Fire Resistance: Non-Combustible, including glazing.
- F. Hail Resistance: Glass assembly shall not break under FM SH hail loading.

- G. Uniform Load: A static air design load of 40 PSF (1916 Pa) shall be applied in the positive and negative direction in accordance with ASTM E 330. There shall be no deflection in excess of L/175 of the span of any framing member at design load. At structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.
- H. Air Leakage: skylights with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of when tested in accordance with ASTM E283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft..
- I. Water Penetration under Static Pressure: skylights that do not evidence water penetration through fixed glazing and framing areas when tested in accordance with ASTM E331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft..
- J. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- K. Condensation Resistance: Provide skylight systems with frame condensation-resistance factor (CRF) as required to meet the specified criteria when tested according to AAMA 1503.
 - 1. Outdoor winter design condition: Base on CEC 2022 Joint Appendix design conditions for project location, California.
 - 2. Outdoor summer design condition: Base on CEC 2022 Joint Appendix design conditions for project location, California.
 - 3. Indoor design conditions:
 - a. Typical building conditions: 70-75 deg F, plus minus 2 degrees; humidity is uncontrolled.
- L. Energy Performance: Provide skylights with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below and certified and labeled according to NFRC:
 - 1. Thermal Transmittance (U-Factor): Fixed glazing and framing areas have U-factor of not more than 0.40 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
 - 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas have a solar heat gain coefficient of no greater than 0.22 as determined in accordance with NFRC 200.

2.2 SKYLIGHTS

- A. Manufacturers:
 - 1. Wasco/Velux – Basis of Design
 - 2. Kawneer North America .
 - 3. Super Sky Products Inc.
 - 4. Or equal
- B. Series: Low Profile LPGS-HU Fixed Skylight .
 - 1. Outside glazed pressure plate system.
 - 2. Mullion Width: As required for application
 - 3. Mullion Depth: As required for application.
- C. Framing Systems:
 - 1. Extruded-aluminum members of thickness required and reinforced as required to support imposed loads is acceptable.

2. Aluminum: Alloy and temper as recommended in writing by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
 - c. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
 - d. Structural Profiles: ASTM B308/B308M.
- D. Cladding Systems and pressure caps: Manufacturer's standard aluminum components that mechanically retain glazing.
 1. Include snap-on aluminum trim that conceals fasteners.
 2. Aluminum: Alloy and temper as recommended in writing by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
 - c. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
 - d. Structural Profiles: ASTM B308/B308M.
 3. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch thick.
- E. Brackets and Reinforcements: Manufacturer's standard high-strength galvanized steel with nonstaining, nonferrous shims for aligning skylight components.
- F. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 1. At pressure caps, use ASTM A193/A193M stainless steel screws.
 2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 3. Reinforce members as required to receive fastener threads.
 4. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- G. Anchor Bolts: ASTM A307, Grade A, galvanized steel.

2.3 GLAZING

- A. Glazing: Factory glazed, laminated insulated glass assembly as specified and per applicable criteria in Section 088000.
 1. Assembly and Total Lite Thickness: Thickness of each lite as required for application, with laminated interior lite.
- B. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 1. Provide skylight glazing with average U-factor of not more than [0.40] Btu/sq. ft. x h x deg F when tested according to AAMA 1503, with frame as shown on drawings, provided by manufacturer's test reports.
 2. Solar Heat Gain Coefficient: Glass and framing areas shall have a solar heat gain coefficient of no greater than [0.22] as determined according to NFRC 200, provided by manufacturer's test reports.
 3. Visual Light Transmission: Glass and framing areas shall have a visual light transmission of [0.42], based on clear exterior and interior panels. Value as determined according to NFRC 200, provided by manufacturer's test reports.

- C. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- D. Spacers and Setting Blocks: Manufacturer's standard elastomeric types. Glazing Sealants: As recommended in writing by manufacturer.
- E. Glazing Sealants:
 - 1. Weatherseal Sealant: ASTM C920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other components with which it comes in contact; and recommended in writing by structural- and weatherseal-sealant and skylight manufacturers for this use.
 - 2. Bond-Breaker Tape: Manufacturer's standard tetrafluoroethylene-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

2.4 FABRICATION

- A. Where practical, fit and assemble skylights in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Fabricate aluminum components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Internal guttering systems or other means to drain water passing joints and moisture migrating within skylight to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
- C. Fabricate aluminum sill closures with weep holes and for installation as continuous component.
- D. Reinforce aluminum components as required to receive fastener threads.
- E. Factory-Glazed, Skylights:
 - 1. Factory install glazing to comply with manufacturers recommendations and applicable requirements in Section 088000 "Glazing."
- F. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.5 ALUMINUM FINISHES

- A. "High-Performance Organic Finish, Type 1: Exterior aluminum elements: AAMA 2605 compliant system, powder coated, color as selected from semi-standard solid color line. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and coating manufacturers' written instructions.
- B. Interior Frame Finish and Color: color as selected by Architect.

PART 3 - EXECUTION – NOT USED

END OF SECTION 086300

SECTION 087100 - DOOR HARDWARE

GUIDELINES

1. *District has established Allegion as the basis of design for all door hardware. Identify current Allegion representative and engage for all hardware.*
2. *Coordinate all electrified hardware with security consultant.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Door hardware, including electric hardware.
 2. Storefront and entrance door hardware.
 3. Gate Hardware.
 4. Third-party inspection report for fire-rated door assemblies.
 5. Card Access control system.
 6. Hand-key biometric access control devices.
 7. Hold-open closers with fire-alarm interface.
 8. Wall or floor-mounted electromagnetic hold-open devices.
 9. Power supplies for electric hardware.
 10. Low energy door operators plus sensors and actuators.
 11. Point-to-point wiring diagrams for electric hardware.
- B. Hardware for the following is specified or indicated elsewhere.
 1. Windows.
 2. Cabinets, including open wall shelving and locks.
 3. Signs, except where scheduled.
 4. Toilet accessories, including grab bars.
 5. Installation.
 6. Rough hardware.
 7. Conduit, junction boxes & wiring.
 8. Folding partitions, except cylinders where detailed.
 9. Sliding aluminum doors, except cylinders where detailed.
 10. Access doors and panels, except cylinders where detailed.
 11. Corner Guards.
 12. Welded steel gates and supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Coordinate all door hardware with District.

ITEM:	MANUFACTURER:	ACCEPTABLE ALTERNATE:
Hinges	(IVE) Ives	None
Continuous Hinges	(IVE) Ives	None
Pivots	(IVE) Ives	None
Key System	(SCH	None
Mechanical Locks	(SCH) Schlage	None
Electronic Locks	(SCE) Schlage Electronics	None
Exit Devices	(VON) Von Duprin	None
Closers	(LCN) LCN	None
Auto Flush Bolts	(IVE) Ives	None
Coordinators	(IVE) Ives	None
Silencers	(IVE) Ives	None
Push & Pull Plates	(IVE) Ives	None
Kickplates	(IVE) Ives	None
Stops & Holders	(IVE) Ives	None
Thresholds	(ZER) Zero	None
Seals & Bottoms	(ZER) Zero	None
Key Cabinets	(LUN) Lund	None
Aluminum Door Locks	(ADA) Adams Rite	None

2.2 HINGING METHODS:

- A. Drawings typically depict doors at 90 degrees, doors will actually swing to maximum allowable. Use wide-throw conventional or continuous hinges as needed up to 8 inches in width to allow door to stand parallel to wall for true 180-degree opening. Advise architect if 8-inch width is insufficient.
- B. Conform to manufacturer's published hinge selection standard for door dimensions, weight and frequency, and to hinge selection as scheduled. Where manufacturer's standard exceeds the scheduled product, furnish the heavier of the two choices, notify Architect of deviation from scheduled hardware.
- C. Conventional Hinges: Steel or stainless-steel pins and approved bearings. Hinge open widths minimum, but of sufficient throw to permit maximum door swing.
 1. Out swinging exterior doors: non-ferrous with non-removable (NRP) pins and security studs.
 2. Non-ferrous material exteriors and at doors subject to corrosive atmospheric conditions.

D. Continuous Hinges:

1. Geared-type aluminum.
 - a. Use wide-throw units where needed for maximum degree of swing, advise the architect if commonly available hinges are insufficient.
 - b. If units are used at storefront openings, color-coordinate hinge finish with storefront color. Custom anodizing and custom powder coat finishes subject to Architect approval.
2. Pinned steel/stainless steel type: continuous stainless steel, 0.25-inch diameter stainless-steel hinge pin.
 - a. Use engineered application-specific wide-throw units as needed to provide maximum swing degree of swing, advise architect if required width exceeds 8 inches.

E. Pivots: high-strength forged bronze or stainless steel, tilt-on precision bearing and bearing pin.

1. Bottom and intermediate pivots: adjustability of minus 0.063 inch, plus 0.125 inch.

2.3 LOCKSETS, LATCHSETS, DEADBOLTS:

A. Mortise Locksets and Latch sets: as scheduled.

1. Chassis: cold-rolled steel, handing field-changeable without disassembly.
2. Universal lock case – 10 functions in one case.
3. Floating mounting tabs automatically adjusts to fit a beveled door edge.
4. Latch bolts: 0.75 inch throw stainless steel anti-friction type.
5. Lever Trim: through-bolted, accessible design, cast lever or solid extruded bar type levers as scheduled. Filled hollow tube design unacceptable.
 - a. Spindles: security design independent breakaway. Breakage of outside lever does not allow access to inside lever's hub works to gain wrongful entry.
 - b. Inside lever applied by screwless shank mounting – no exposed trim mount screws.
 - c. Levers rotate up or down for ease of use.
 - d. Vandal Gard locks: locked lever freely rotates down while remaining securely locked. This feature prevents damage to internal lock components when subjected to excessive force.
6. Furnish solid cylinder collars with wave springs. Wall of collar to cover rim of mortise cylinder.
7. Turn pieces: accessible offset turn-lever design not requiring pinching or twisting motions to operate.
8. Deadbolts: stainless steel 1-inch throw.
9. Electric operation: Manufacturer-installed continuous duty solenoid.
10. Strikes: 16 gage curved steel, bronze or brass with 1-inch-deep box construction, lips of sufficient length to clear trim and protect clothing.
11. Scheduled Lock Series and Design: Schlage L series, 06A design.
12. Certifications:
 - a. ANSI A156.13, Grade 1 Operational, Grade 1 Security.
 - b. ANSI/ASTM F476-84 Grade 31 UL Listed.
13. Accessibility: Require not more than 5 lb. to retract the latch bolt or deadbolt, or both, per CBC 2022 11B-404.2.7 and 11B-309.4.

2.4 EXIT DEVICES / PANIC HARDWARE

A. General features:

1. Independent lab-tested 1,000,000 cycles.

2. Push-through push-pad design. No exposed push-pad fasteners, no exposed cavities when operated. Return stroke fluid dampeners and rubber bottoming dampeners, plus anti-rattle devices.
3. Deadlocking latch bolts, 0.75-inch projection.
4. End caps: impact-resistant, flush-mounted. No raised edges or lips to catch carts or other equipment.
5. No exposed screws to show through glass doors.
6. Non-handed basic device design with center case interchangeable with all functions, no extra parts required to effect change of function.
7. Releasable in normal operation with 15-pound maximum operating force per UBC Standard 10-4, and with 32-pound maximum pressure under 250-pound load to the door.
8. Exterior doors scheduled with XP-series devices: Static load force resistance of at least 2000 pounds.
9. Accessibility: Require not more than 5 lb. to retract the latch bolt, per CBC 2022 11B-404.2.7 and 11B-309.4.
 - a. Mechanical method: Von Duprin "AX-" feature, where touchpad directly retracts the latch bolt with 5 lb. or less of force. Provide testing lab certification confirming that the mechanical device is independent third-party tested to meet this 5 lb. requirement.
 - b. Electrical method: Von Duprin's "RX-QEL-" , where lightly pressing the touchpad with 5 lb. or less of force closes an electric switch, activating quiet electric latch retraction.

B. Specific features:

1. Non-Fire Rated Devices: cylinder dogging.
2. Lever Trim: breakaway type, forged brass or bronze escutcheon min. 0.130-inch thickness, compression spring drive, match lockset lever design.
3. Rod and latch guards with sloped full width kickplates for doors fitted with surface vertical rod devices with bottom latches.
4. Fire-Labeled Devices: UL label indicating "Fire Exit Hardware". Vertical rod devices less bottom rod (LBR) unless otherwise scheduled.
5. Delayed Egress Devices: Function achieved within single exit device component, including latch, delayed locking device, request-to-exit switch, nuisance alarm, remote alarm, key switch, indicator lamp, relay, internal horn, door position input, external inhibit input plus fire alarm input. NFPA 101 "Special Locking Arrangement" compliant.
6. Electrically Operated Devices: Single manufacturer source for electric latch retraction devices, electrically controlled trim, power transfers, power supplies, monitoring switches and controls.
7. Removable Mullions: Removable with single turn of building key. Securely reinstalled without need for key. Furnish storage brackets for securely stowing the mullion away from the door when removed.

2.5 CLOSERS

A. Surface Closers:

1. Full rack-and-pinion type cylinder with removable non-ferrous cover and cast-iron body. Double heat-treated pinion shaft, single piece forged piston, chrome-silicon steel spring.
2. ISO 2000 certified. Units stamped with date-of-manufacture code.
3. Independent lab-tested 10,000,000 cycles.
4. Non-sized, non-handed, and adjustable. Place closer inside building, stairs, and rooms.
5. Plates, brackets and special templating when needed for interface with particular header, door and wall conditions and neighboring hardware.

6. Adjust doors to open with not more than 5.0-pounds pressure to open at exterior doors and 5.0-pounds at interior doors. As allowed per 2022 California Building Code Section 11B-404.2.9, local authority may increase the allowable pressure for fire doors to achieve positive latching, but not to exceed 15-pounds.
 - a. Exception: exterior doors' pressure-to-open may be increased to 8.5-pounds if: at a single location, and one of a bank of eight leafs or fraction of eight, and one leaf of this bank is fitted with a low- or high-energy operator.
7. Separate adjusting valves for closing speed, latching speed and backcheck, fourth valve for delayed action where scheduled.
8. Extra-duty arms (EDA) at exterior doors scheduled with parallel arm units.
9. Exterior door closers: tested to 100 hours of ASTM B117 salt spray test, furnish data on request.
10. Exterior doors: seasonal adjustments not required for temperatures from 120 degrees F to -30 degrees F, furnish checking fluid data on request.
11. Non-flaming fluid will not fuel door or floor covering fires.
12. Pressure Relief Valves (PRV) not permitted.

B. LCN Senior Swing:

1. Comply with ANSI/BHMA 156.19 and 2022 California Building Code Section 11B-404.2.9, Exception 2: Electric power-open and close operation. Modular construction. Finished metal cover. Field-adjustable opening force, opening speed, time-open, closing and latching speeds. Door reopens and timing cycles restore if system activated during closing cycle. Breakaway clutch protection from forced closing. Door, frame, motor and drive train protected by attenuated initiation of opening cycle.
2. Self-contained low-voltage power supply, terminal strip and sequencing for incorporation of electric hardware with system operation.
3. Actuators: as scheduled
 - a. Vertical bar type: minimum 2 inches wide by 30 inches in height. Locate bar with bottom 5 inches maximum above finish floor, and top 35 inches minimum above finish floor.
 - b. Actuators of either type: display International Symbol of Accessibility (ISA) pictogram.
4. Safety sensors: as scheduled.

2.6 OTHER HARDWARE

- A. Automatic Flush Bolts: Low operating force design.
- B. Overhead Stops: Non-plastic mechanisms and finished metal end caps. Field-changeable hold-open, friction and stop-only functions.
- C. Kick Plates: Four beveled edges, .050 inches minimum thickness, height and width as scheduled. Sheet-metal screws of bronze or stainless steel to match other hardware.
- D. Doorstops: Provide stops to protect walls, casework or other hardware.
 1. Unless otherwise noted in Hardware Sets, provide floor type with appropriate fasteners. Where floor type cannot be used, provide wall type. If neither can be used, provide overhead type.
- E. Locate overhead stops for maximum possible opening. Consult with Owner for furniture locations. Minimum: 90deg stop / 95deg dead stop. Note degree of opening in submittal.
- F. Automatic door bottoms: low operating force units. Doors with automatic door bottoms plus head and jamb seals cannot require more than two pounds operating force to open when closer is disconnected.
 1. Include automatic type door bottoms, as opposed to fixed sweeps, at stairs and elevator lobbies to allow fine-tuning of pressurization systems.

- G. Thresholds: As scheduled and per details. Comply with CBC 2022 11B-404.2.5. Substitute products: certify that the products equal or exceed specified material's thickness. Proposed substitutions: submit for approval.
1. Saddle thresholds: 0.125 inches minimum thickness.
 2. Exteriors: Seal perimeter to exclude water and vermin. Use sealant complying with requirements in Division 7 "Thermal and Moisture Protection". Minimum 0.25-inch diameter fasteners and lead expansion shield anchors, or Red-Head #SFS-1420 (or approved equivalent) Flat Head Sleeve Anchors. National Guard Products' "COMBO" or Pemko Manufacturing's "FHSL".
 3. Fire-rated openings, 90-minutes or less duration: use thresholds to interrupt floor covering material under the door where that material has a critical radiant flux value less than 0.22 watts per square centimeter, per NFPA 253. Use threshold unit as scheduled. If none scheduled, include a 0.25in high 5in wide saddle in the bid, and request direction from Architect.
 4. Fire-rated openings, 3-hour duration: Thresholds, where scheduled, to extend full jamb depth.
 5. Acoustic openings: Set units in full bed of Division-7-compliant, leave no air space between threshold and substrate.
 6. Plastic plugs with wood or sheet metal screws are not an acceptable substitute for specified fastening methods.
 7. Fasteners: Generally, exposed screws to be Phillips or Robertson drive. Pinned TORX drive at high security areas. Flat head sleeve anchors (FHSL) may be slotted drive. Sheet metal and wood screws: full thread. Sleeve nuts: full length to prevent door compression.
- H. Through-bolts: Do not use. Coordinate with wood doors; ensure provision of proper blocking to support wood screws for mounting panic hardware and door closers. Coordinate with metal doors and frames; ensure provision of proper reinforcement to support machine screws for mounting panic hardware and door closers.
1. Exception: surface-mounted overhead stops, holders, and friction stays.
- I. Silencers: Interior hollow metal frames, 3 for single doors, 4 for pairs of doors. Leave no unfilled/uncovered pre-punched silencer holes. Intent: door bears against silencers, seals make minimal contact with minimal compression – only enough to effect a seal.
- 2.7 FINISH:
- A. Generally: BHMA 626 Satin Chromium.
1. Areas using BHMA 626: furnish push-plates, pulls and protection plates of BHMA 630, Satin Stainless Steel, unless otherwise scheduled.
- B. Door closers: factory powder coated to match other hardware, unless otherwise noted.
- 2.8 KEYING REQUIREMENTS:
- A. Key System: As indicated. Initiate and conduct meeting(s) with the Owner to determine system structure, furnish Owner's written approval of the system; do not order keys or cylinders without written confirmation of actual requirements from the District. Furnish cylinders as required to District Facilities Management. District Facilities Management will key cylinders as required and then install.

2.9 HARDWARE SCHEDULE GUIDE

A. Coordinate applicable hardware with District designated current Allegion representative.

Key System	Schlage: Classic Primus FSIC *Consult facilities for keying instructions.
Locksets	Mortise: Schlage L9000, 03 L 626. Functions will vary. Classroom Security Indicators. Cylindrical: Do not specify. *Consult facilities for keying instructions.
Padlocks	Kryptonite by Schlage.
Exit Devices	Von Duprin: HEX AX 99L 06, US26D (med/wide stile doors) Von Duprin: -2 AX 99L 06- F, US26D (fire rated doors) Electrified Devices: QEL 99L, US26D or QEL 99L –F for rated openings. *Add proper power supply depending on additional hardware required at opening.
Power Supply	Von Duprin: PS902/904/914 *Power supply will vary per application required by additional electrified hardware.
Mullions	Von Duprin: KR 4954 series with MT54 storage bracket kits. *KR series mullions and rim devices at pairs of doors.
Surface Closers/Auto Operators	Interior/Exterior: LCN 4040XP *Use security screws. No self-tapping screws. Floor Closers: New-Do not specify. Remove existing. Auto Operators: LCN 9550 Senior Swing, LCN 4600 series <u>per specific instructions</u> .
Auto-Flush Bolts	Ives: FB30-40-50-60 Series. Flush Bolts: Ives FB30-40 (automatic) Series and FB50-60 (constant) as required or equal.
Pivots	Ives 7200 series (only as required)
Hinges	Ives- Continuous Hinges, 224 HD, 112 HD (high use doors and electrified openings with EPT) Ives-5 knuckle ball bearing mortise. 5BB 1 4.5x 4.5 626, SH (security studs for perimeter doors) *EPT where electronics required with continuous hinges.
Overhead Stops	Do not specify.
Floor/Wall Stops	Floor Interior: Ives FS436 or FS438. Wall: Ives WS401/402 use only when req'd Floor Exterior: Ives FS18, WS40 series or FS40 series at heavy-duty applications. Wall Stops: On interior doors only. Ives 50/60C Series (use when necessary).
Door Plates	Kickplates: Ives 8400 Series 10'X 2' less than door width (1*LDW at non mullioned pairs).

B.

	Push/Pull Plates: Ives 8200/8303-8 series
Thresholds	Zero International
Door Seals	Zero International

PART 3 - EXECUTION – NOT USED

END OF SECTION 087100

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SECTION 088000 - GLAZING

GUIDELINES

1. *Comply with DSA Delegated Design/Deferred approval requirements for glass thickness. Prepare project specific DSA procedures.*
2. *Assess acoustical criteria based on CalGreen external noise sources and provide laminated glass as appropriate.*
3. *Specify glass performance values based on energy analysis method and compliance with design and Title 24, Part 6.*
4. *Note recommendation for heat soak procedure for tempered glass. Verify approach with Owner and consider cost and schedule impact.*
5. *Consider "active shooter" potential and use of appropriately ballistic rated glass and frames. Review updated UL 752 and recently issued ASTM F3561.*

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - a. Windows.
 - b. Doors.
 - c. Glazed curtain walls.
 - d. Storefront framing.
 - e. Skylights.
 - f. Interior borrowed lites.
2. Glazing sealants and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 and 2022 California Building Code by a qualified professional engineer.

- C. Exterior Glass Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the CBC and ASTM E 1300.
 - 1. Design Wind Pressures: [As indicated on Structural Drawings][Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour at 33 feet above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade as modified by the CBC, Chapter 1616A.]
 - 2. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Seismic Performance: All-glass entrances shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 as modified **by CBC Chapter 16A and 24.**
- F. Tempered Glass Heat Soak Source quality-control reports: For tempered glass; including the following:
 - 1. Traceability of glass; source of supply and evidence of batching.
 - 2. Dates of toughening/heat soaking.
 - 3. Certification that 100 percent of the glass units have been heat soak-tested in a calibrated oven.
 - 4. Records of latest heat soak oven calibration date.
 - 5. Records to include details of all units that failed during the heat soak test.
- G. Safety Glazing Requirements: Comply with **the California Building Code, including Chapter 24, ANSI Z97.1 and CPSC Title 16 Part 1201 (16 CFR 1201).**
 - 1. Permanently mark all glazing with approved identification.

2.3 GLASS PRODUCTS

- A. Ultra clear Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I, complying with other requirements specified and with visible light transmission not less than 91 percent [and solar heat gain coefficient not less than 0.87].
- B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- C. Heat-Treated Float Glass: ASTM C 1048; Kind HS (heat strengthened), Type I; Class I (clear) or Class 2 (tinted) as indicated; Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 - 2. For uncoated glass, comply with requirements for Condition A.
 - 3. For coated vision glass, comply with requirements for Condition C (other coated glass).
- D. Uncoated Tinted Float Glass: ASTM C 1036, Type I, Class 2, Quality-Q3 complying with other requirements specified.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. <Insert, in separate subparagraphs, manufacturer's name>.
 - 2. Tint Color: [Blue] [Blue green] [Bronze] [Green] [Gray].

- E. Ceramic-Coated Vision Glass: ASTM C 1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in GANA's Tempering Division's "Engineering Standards Manual" and with other requirements specified.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. <Insert, in separate subparagraphs, manufacturer's name; product name or designation>.
 2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. <Insert, in separate subparagraphs, manufacturer's name>.
 3. Glass: Clear float Ultra clear float.
 4. Tint Color: [Blue] [Blue green] [Bronze] [Green] [Gray] <Insert color>.
- F. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B, Type I, Quality-Q3, and complying with other requirements specified.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. <Insert, in separate subparagraphs, manufacturer's name; product name or designation>.
 2. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. <Insert, in separate subparagraphs, manufacturer's name>.
 3. Glass: <specify glass>, fully tempered.
 4. Ceramic Coating Color: [As selected by Architect from manufacturer's full range] [Match] [Provide] <Insert one manufacturer's color designation if matching is required; otherwise, insert color designation for each product named above>.
- G. Silicone-Coated Spandrel Glass: ASTM C 1048, Condition C, Type I, Quality-Q3, and complying with other requirements specified.
1. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. <Insert, in separate subparagraphs, manufacturer's name>.
 2. Glass: <specify glass>, fully tempered.
 3. Tint Color: [Blue] [Blue green] [Bronze] [Green] [Gray].
 4. Silicone Coating Color: [As selected by Architect from manufacturer's full range] [Match] [Provide] <Insert one manufacturer's color designation if matching is required; otherwise, insert color designation for each product named above>.

2.4 LAMINATED GLASS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

- B. Laminated Glass: ASTM C 1172 and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
 - 1. Construction: Laminate glass with [polyvinyl butyral interlayer] [or] [cast-in-place and cured-transparent-resin interlayer] to comply with interlayer manufacturer's written recommendations.
 - 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 - 3. Interlayer Color: Clear unless otherwise indicated.
- C. Laminated Glass Characteristics:
 - 1. Interlayer Thickness: Minimum 0.060 inch.
 - 2. Interlayer Physical Properties:
 - a. Youngs Modulus: 43 kpsi, when tested in accordance with ASTM D5026.
 - b. Tensile Strength: 5.0 kpsi, when tested in accordance with ASTM D 638.
 - c. Elongation: 400 percent, when tested in accordance with ASTM D 638.
 - d. Flex Modulus: 50 kpsi, when tested in accordance with ASTM D790.
 - e. Heat Deflection Temperature at 0.46 MPa: 110 deg. F, when tested in accordance with ASTM D638.
 - 3. Glass Unit Edge Finishing: Ground and polished.
- D. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Laminated-Glass Types" Article.

2.5 INSULATING GLASS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1. <Insert, in separate subparagraphs, manufacturer's name>.
- B. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other specified requirements.
 - 1. Sealing System: Dual seal, with [manufacturer's standard] [polyisobutylene and polysulfide] [polyisobutylene and silicone] [polyisobutylene and hot-melt butyl] [polyisobutylene and polyurethane] primary and secondary sealants.
 - a. Insulating glass seals: Provide black polyisobutylene (PIB) in the primary IGU seal. Use of gray PIB in IGU seal is not acceptable.
 - 2. Spacer: [Manufacturer's standard spacer material and construction] [Aluminum with mill or clear anodic finish] [Aluminum with black, color anodic finish] [Aluminum with bronze, color anodic finish] [Aluminum with powdered metal paint finish in color selected by Architect] [Galvanized steel] [Stainless steel] [Polypropylene covered stainless steel in color selected by Architect] [Thermally broken aluminum] [Nonmetallic laminate] [Nonmetallic tube] [Silicone with integral desiccant and vapor barrier] <Insert material>.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Technoform Glass Insulation NA, Inc.; TGI-Spacer.
 - 2) Thermix; a brand of Ensinger USA; Thermix.

3. Warm Edge Spacer:
 - a. Basis-of-Design Product: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) TGI Warm Edge Spacer by Technoform Group.
 - b. Provide letter of acceptance of use of warm edge spacer with glass materials by glass manufacturer including documentation of edge system structural adequacy for applications in Project.

4. Desiccant: Molecular sieve or silica gel, or blend of both.

- C. Glass: Comply with applicable requirements in "Glass Products" Article and in "Laminated Glass" Article as indicated by designations in "Insulating-Glass Types" Article [and in "Insulating-Laminated-Glass Types" Article].

2.6 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from [one of] the following:
 1. Neoprene complying with ASTM C 864.
 2. EPDM complying with ASTM C 864.
 3. Silicone complying with ASTM C 1115.
 4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned [neoprene] [EPDM] [silicone] [or] [thermoplastic polyolefin rubber] gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 1. AAMA 804.3 tape, where indicated.
 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.9 MONOLITHIC-GLASS SCHEDULE

- A. Glass Type <Insert designation>: Clear [fully tempered] [heat-strengthened] float glass.
 - 1. Thickness: As required by delegated design, minimum 6.0 mm.
 - 2. Provide safety glazing labeling as required.
- B. Glass Type Insert designation: Ultra clear [fully tempered] [heat-strengthened]float glass.
 - 1. Basis-of-Design Product:
 - a. AGC Glass Company North America, Inc.; Krystal Klear
 - b. Guardian Industries Corp.; Ultra white
 - c. Pilkington North America Inc.; Opti white
 - d. PPG Industries, Inc.; Starphire
 - e. Saint-Gobain Corporation; Diamant
 - f. Insert manufacturer's name; product name or designation.
 - 2. Thickness: As required by delegated design, minimum 6.0 mm. .
 - 3. Provide safety glazing labeling.
- C. Glass Type Insert designation: Ceramic-coated vision glass [fully tempered] [heat-strengthened]float glass.
 - 1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 - 2. Minimum Thickness: As required by delegated design, minimum 6.0 mm. .
 - 3. Glass: Clear Ultra clear float glass.
 - 4. Tint Color: Blue green Bronze Green Gray Insert color.
 - 5. Ceramic Coating Color and Pattern: As selected by Architect from manufacturer's full range Match Architect's samples Insert one manufacturer's color and pattern designation if matching is required Insert manufacturer; color and pattern designation.
 - 6. Coating Location: Second surface.
 - 7. Winter Nighttime U-Factor: Insert value maximum.
 - 8. Summer Daytime U-Factor: Insert value maximum.
 - 9. Visible Light Transmittance: Insert number percent minimum.
 - 10. Solar Heat Gain Coefficient: Insert value maximum.
 - 11. Provide safety glazing labeling.
- D. Glass Type Insert designation: Ceramic-coated spandrel glass, [fully tempered] [heat-strengthened]float glass.
 - 1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 - 2. Glass: float glass.
 - 3. Tint Color: Blue green Bronze Green Gray Insert color.

4. Coating Color: As selected by Architect from manufacturer's full range Match Architect's samples Insert one manufacturer's color designation if matching is required Insert manufacturer; color designation.
 5. Minimum Thickness: 6.0 mm Insert thickness designation.
 6. Coating Location: Second surface.
 7. Winter Nighttime U-Factor: Insert value maximum.
 8. Summer Daytime U-Factor: Insert value maximum.
 9. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.
- E. Glass Type Insert designation: Silicone-coated spandrel glass, [fully tempered] [heat-strengthened]float glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Glass: Clear float glass.
 3. Tint Color: Blue green Bronze Green Gray Insert color.
 4. Coating Color: As selected by Architect from manufacturer's full range Match Architect's samples Insert one manufacturer's color designation if matching is required Insert manufacturer; color designation.
 5. Minimum Thickness: 6.0 mm Insert thickness designation.
 6. Coating Location: Second surface.
 7. Winter Nighttime U-Factor: Insert value maximum.
 8. Summer Daytime U-Factor: Insert value maximum.
 9. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.

2.10 LAMINATED-GLASS SCHEDULE

- A. Glass Type Insert designation: Clear laminated glass with two plies of fully tempered float glass ultra clear fully tempered float glass.
1. Minimum Thickness of Each Glass Ply: [3.0] [4.0] [5.0] [6.0] mm [As indicated][Insert thickness designation.]
 2. Interlayer Thickness: [0.030 inch] [0.060 inch][0.090 inch.]
 3. Provide safety glazing labeling.
- B. Glass Type Insert designation: Ceramic-coated, laminated vision glass with two plies of fully tempered float glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Outer Ply: Clear float glass.
 3. Tint Color: Blue green Bronze Green Gray Insert color.
 4. Inner Ply: Clear float glass.
 5. Ceramic Coating Color and Pattern: As selected by Architect from manufacturer's full range Match Architect's samples Insert one manufacturer's color and pattern designation if matching is required Insert manufacturer; color and pattern designation.
 6. Minimum Thickness of Each Glass Ply: [3.0] [4.0] [5.0] [6.0] mm [As indicated][Insert thickness designation.]
 7. Interlayer Thickness: [0.030 inch] [0.060 inch][0.090 inch.]
 8. Coating Location: Second Third Fourth surface.
 9. Winter Nighttime U-Factor: Insert value maximum.
 10. Summer Daytime U-Factor: Insert value maximum.
 11. Visible Light Transmittance: Insert number percent minimum.
 12. Solar Heat Gain Coefficient: Insert value maximum.
 13. Provide safety glazing labeling.

- C. Glass Type Insert designation: Low-E-coated, laminated vision glass with two plies of clear fully tempered float glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Minimum Thickness of Each Glass Ply: [3.0] [4.0] [5.0] [6.0] mm [As indicated][Insert thickness designation.]
 3. Interlayer Thickness: [0.030 inch] [0.060 inch][0.090 inch.]
 4. Low-E Coating: Pyrolytic on second Pyrolytic on third Sputtered on second Sputtered on third Pyrolytic or sputtered on second or third surface.
 5. Visible Light Transmittance: Insert value percent minimum.
 6. Winter Nighttime U-Factor: Insert value maximum.
 7. Summer Daytime U-Factor: Insert value maximum.
 8. Solar Heat Gain Coefficient: Insert value maximum.
 9. Provide safety glazing labeling.

2.11 INSULATING-GLASS SCHEDULE

- A. Glass Type Insert designation: Low-e-coated, clear insulating glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: As required by delegated design, Minimum 1 inch Insert dimension.
 3. Minimum Thickness of Each Glass Ply: [3.0] [4.0] [5.0] [6.0] mm [As indicated][Insert thickness designation.]
 4. Outdoor Lite: Fully tempered Ultra clear fully tempered Heat-strengthened Ultra clear heat-strengthened float glass.
 5. Interspace Content: Air Argon.
 6. Indoor Lite: Fully tempered Ultra clear fully tempered Heat-strengthened Ultra clear heat-strengthened float glass.
 7. Low-E Coating: Pyrolytic on second Pyrolytic on third Sputtered on second Sputtered on third Pyrolytic or sputtered on second or third surface.
 8. Visible Light Transmittance: Insert value percent minimum.
 9. Winter Nighttime U-Factor: Insert value maximum.
 10. Summer Daytime U-Factor: Insert value maximum.
 11. Solar Heat Gain Coefficient: Insert value maximum.
 12. Provide safety glazing labeling.
- B. Glass Type Insert designation: Ceramic-coated Silicone-coated, insulating spandrel glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Coating Color: As selected by Architect from manufacturer's full range Match Architect's samples Insert one manufacturer's color designation if matching is required Insert manufacturer; color designation.
 3. Overall Unit Thickness: As required by delegated design, minimum 1 inch .
 4. Minimum Thickness of Each Glass Ply: [3.0] [4.0] [5.0] [6.0] mm [As indicated][Insert thickness designation.]
 5. Outdoor Lite: Fully tempered Ultra clear fully tempered Heat-strengthened Ultra clear heat-strengthened float glass.
 6. Interspace Content: Air Argon.
 7. Indoor Lite: Fully tempered Ultra clear fully tempered Heat-strengthened Ultra clear heat-strengthened float glass.
 8. Coating Location: Fourth surface.
 9. Winter Nighttime U-Factor: Insert value maximum.
 10. Summer Daytime U-Factor: Insert value maximum.

- C. Glass Type Insert designation: Ceramic-coated Silicone-coated, low-E, insulating spandrel glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Coating Color: As selected by Architect from manufacturer's full range Match Architect's samples Insert one manufacturer's color designation if matching is required Insert manufacturer; color designation.
 3. Overall Unit Thickness: 1 inch Insert dimension.
 4. Minimum Thickness of Each Glass Ply: [3.0] [4.0] [5.0] [6.0] mm [As indicated][Insert thickness designation.]
 5. Outdoor Lite: Fully tempered Ultra clear fully tempered Heat-strengthened Ultra clear heat-strengthened float glass.
 6. Interspace Content: Air Argon.
 7. Indoor Lite: Fully tempered Ultra clear fully tempered Heat-strengthened Ultra clear heat-strengthened float glass.
 8. Low-E Coating: Pyrolytic on second Pyrolytic on third Sputtered on second Sputtered on third Pyrolytic or sputtered on second or third surface.
 9. Opaque Coating Location: Fourth surface.
 10. Winter Nighttime U-Factor: Insert value maximum.
 11. Summer Daytime U-Factor: Insert value maximum.

2.12 INSULATING-LAMINATED-GLASS SCHEDULE

- A. Glass Type Insert designation: Low-E-coated, clear insulating laminated glass.
1. Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.
 2. Overall Unit Thickness: [1-3/16 inch][1 inch][3/4 inch][Insert dimension.]
 3. Minimum Thickness of Each Glass Ply: [3.0] [4.0] [5.0] [6.0] mm [As indicated][Insert thickness designation.]
 4. Interlayer Thickness: [0.030 inch] [0.060 inch][0.090 inch.]
 5. Minimum Thickness of Outdoor Lite: [3.0 mm][4.0 mm][5.0 mm][6.0 mm][Insert dimension.]
 6. Outdoor Lite: Fully tempered Heat-strengthened float glass.
 7. Interspace Content: Air Argon.
 8. Indoor Lite: Clear laminated glass with two plies of fully tempered heat-strengthened float glass.
 - a. Minimum Thickness of Each Glass Ply: [3.0] [4.0] [5.0] [6.0] mm [As indicated]
 - b. Interlayer Thickness: 0.030 inch 0.060 inch 0.090 inch.
 9. Low-E Coating: Pyrolytic on second Pyrolytic on third Sputtered on second Sputtered on third Pyrolytic or sputtered on second or third surface.
 10. Visible Light Transmittance: Insert value percent minimum.
 11. Winter Nighttime U-Factor: Insert value maximum.
 12. Summer Daytime U-Factor: Insert value maximum.
 13. Solar Heat Gain Coefficient: Insert value maximum.
 14. Provide safety glazing labeling.

PART 3 - EXECUTION – NOT USED

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SECTION 090561.13 - MOISTURE VAPOR EMISSION CONTROL

GUIDELINES

1. *There are multiple manufacturers providing Moisture Vapor Emission Resistant coatings. This Section recommends a membrane forming system applied after concrete is placed and cured, as versus integral admixtures or topical applications. Alternate topical applications may be suitable with District approval for demonstrated performance including shrinkage cracking.*
2. *Define application method. System may be applied to the entire surface before partition construction (with adequate protection), or applied only at locations where MVER testing shows values in excess of flooring manufacturers limits.*
3. *Certain resilient flooring adhesives may be specified in the respective Sections that can reduce the need for the MVER system.*

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fluid-applied, resin-based, membrane-forming systems that control the moisture-vapor-emission rate of high-moisture, interior concrete, at below grade, on-grade and above grade applications, to prepare it for floor covering installation of the following floor finishes:
 - a. Resilient Sheet and Resilient Tile Flooring.
 - b. Carpet
 - c. Wood Flooring
2. Do not apply at floor substrates with resin or epoxy flooring systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
 1. MVER: Maximum 25 lb. of water/1000 sq. ft. when tested according to ASTM F1869.
 2. Relative Humidity: Maximum **90** percent when tested according to ASTM F2170 using in situ probes.
 3. Alkalinity Level: System suitable for installation on slabs exhibiting pH values up to and including 14
- B. Water-Vapor Transmission: Through MVE-control system, maximum [0.10 perm] [0.02 perm] [0.06 perm] when tested according to ASTM E96/E96M.
- C. Tensile Bond Strength: For MVE-control system, greater than [200 psi] **<Insert pressure>** with failure in the concrete according to ASTM D7234.
- D. VOC Compliance: Comply with SCAQMD regulations for primers, coatings, and sealers.
- E. Fire/Life Safety/Habitability Criteria
 1. Flammability: Provide non-flammable products.
 2. Hazard Rating: Materials used shall be rated non-hazardous under OSHA regulations.

2.2 MVE-CONTROL SYSTEM

- 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. ARDEX Americas.
 2. Floor Seal Technology, Inc.
 3. KOSTER American Corporation.
- B. MVE-Control System- Epoxy: ASTM F3010-qualified, fluid-applied, two-component, epoxy-resin, membrane-forming system; formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
 - a. KOSTER American Corporation; **Koster VAP I 2000**.
 - b. Floor Seal Technology; MES 100
 - c. MAPEI Corporation; **[Planiseal EMB] [Planiseal VS Fast] [Planiseal VS]**.
 2. Substrate Primer: Provide MVE-control system manufacturer's concrete-substrate primer if required for system indicated by substrate conditions.
 3. Cementitious Underlayment Primer: If required for subsequent installation of cementitious underlayment products, provide MVE-control system manufacturer's primer to ensure adhesion of products to MVE-control system.
 4. VOC Content: Provide coating with VOC content of 100 g/L or less.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

GUIDELINES

1. *Specification includes provisions for gypsum board installation prior to enclosure. This may expose gypsum board shafts, perimeter walls and other assemblies to moisture damage. See HCAI CAN -2-2508 for guidance.*
2. *Most District projects will require DSA review and not use delegated design. Where project allows delegated design, establish appropriate load and deflection criteria.*
3. *District prefers impact resistant gypsum board at stairs.*
4. *Establish appropriate deflection values for acoustic and fire-rate head-of-wall conditions.*
5. *Coordinate elevator shaft wall cants and offset dimensions with California Title 8 elevator code.*
6. *Designate acoustic and fire ratings for each shaft wall application on drawings.*
7. *Specify that all exposed gypsum board edges shall receive an edge trim, including cut edges.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes gypsum board shaft wall assemblies for the following:
1. Shaft-wall enclosures.
 2. Chase enclosures.
 3. Stair enclosures.
 4. Horizontal enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
1. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
 2. Provide auxiliary materials and components, complying with gypsum board shaft-wall assembly manufacturer's written recommendations and compatible with head-of-wall tested assemblies as indicated on Drawings.
- B. Moisture Control: Do not install interior products until installation areas are enclosed and conditioned including, but not limited to, the following general minimum parameters for paper-faced gypsum board and finishing compounds:
1. Surfaces exposed to weather, including:
 - a. Shafts and unprotected openings in horizontal surfaces directly exposed to snow, water, dew or condensation.
 - b. Walls within a horizontal distance from an exterior opening of two times the height of the exterior opening.
 2. No visible water sources in contact with gypsum board.
 3. Minimum 40 degrees F for gypsum board installation.
 4. Minimum 50 degrees F throughout finishing process including compound drying time.
 5. Building ventilation sufficient to allow compound to dry within 10 hours.

6. When the Contractor's proposed construction schedule or construction conditions indicates paper faced gypsum board will be installed in conflict with specified requirements, comply with the following:
 - a. Provide glass mat gypsum sheathing board in lieu of paper faced gypsum board meeting specified performance requirements and assembly criteria.
 - b. Provide Informational submittal showing glass mat gypsum sheathing board locations.
- C. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E90 and classified according to ASTM E413 by a testing and inspecting agency.
- D. Framing Members, General: Comply with ASTM C745 unless otherwise indicated.
 1. Steel Sheet Components: Comply with AISI S220 requirements for metal unless otherwise indicated
 2. Protective Coating:
 - a. Provide ASTM A653/A653M G40 hot-dip galvanized, unless otherwise indicated.
 - b. Provide ASTM A653/A653M G60 hot-dip galvanized coating on all framing members to receive:
 - 1) Mold-Resistant Gypsum Board.
 - 2) Tile Backing Board.
 - 3) All framing members installed prior to building dry-in.
- E. Assembly Membrane Finish:
 1. Room-Side Finish Panels: As indicated on Drawings and as specified in Section 092900.
 2. Shaft-Side Finish: As indicated on Drawings and as specified in this Section.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Gypsum Shaftliner Board:

1. Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with paper faces, 1 inch thick, with double beveled long edges.
 - 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) Georgia-Pacific Gypsum LLC.
 - 2) National Gypsum Company.
 - 3) PABCO Gypsum.
 - 4) USG Corporation.
2. Moisture- and Mold-Resistant Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with ASTM D3273 mold-resistance score of 10 as rated according to ASTM D3274, 1 inch thick, and with double beveled long edges.
 - 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) Georgia-Pacific Gypsum LLC.
 - 2) National Gypsum Company.
 - 3) PABCO Gypsum.
 - 4) USG Corporation.

3. Moisture- and Mold-Resistant, Fiberglass-Mat Faced: ASTM C1658/C1658M; manufacturer's proprietary fire-resistive liner panels with ASTM D3273 mold-resistance score of 10 as rated according to ASTM D3274, 1 inch thick, and with double beveled long edges.
 - 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) Georgia-Pacific Gypsum LLC.
 - 2) National Gypsum Company
 - 3) PABCO Gypsum
 - 4) USG Corporation.

2.3 SHAFTWALL FRAMING SYSTEMS

- A. Studs:
 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. MarinoWare
 - b. Clark Dietrich Building Systems.
 - c. SCAFCO Steel Stud Company.
 2. Depth: As indicated.
 3. Minimum Base-Metal Thickness: As indicated.
 4. Minimum Steel Strength: Minimum Yield Strength of 33 ksi.
 5. Type of Studs: Plain steel studs.
- B. Slip-Type Head Joints: Provide the following as indicated on Drawings:
 1. Slotted Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Basis-of-Design Product: Subject to compliance with requirements, MarinoWARE; Slotted Deflection Track with minimum 3 inch legs.
 - b. Slotted Deflection Track Fire-Resistive Joint Accessories:
 - 1) Products: Subject to compliance with requirements, provide the following as required UL Head-of-Wall conditions as indicated on Drawings.
 - a) CEMCO FAS STRAP.
 - b) CEMCO FIRE RIP 2.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 092216 - NON-STRUCTURAL METAL FRAMING

GUIDELINES

1. Most District projects will require DSA review, and not use delegated design. Where project allows delegated design, establish appropriate load and deflection criteria.
2. Establish appropriate deflection values for acoustic and fire rated head of wall conditions.
3. Designate acoustic and fire ratings for each shaft wall application on drawings.
4. Verify wall design reflects composite wall definition.

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide non-structural metal framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on Drawings.

a. Live Loads:

- 1) Handrail Loads:

- a) Uniform load of 50 lbf/ ft. applied in any direction.
- b) Concentrated load of 200 lbf applied in any direction.
- c) Uniform and concentrated loads need not be assumed to act concurrently.

- 2) Grab Bars: Installed units can resist 250 lbf concentrated load applied in any direction and at any point.

2. Seismic Loads: As indicated on Structural Drawings.

3. Deflection Limit: As indicated on Drawings.

4. Lateral Partition Loads: As indicated on Drawings.

B. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.

1. Provide auxiliary materials and components, complying with gypsum board shaft-wall assembly manufacturer's written recommendations and compatible with head-of-wall tested assemblies as indicated on Drawings.

C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.

2.2 FRAMING SYSTEMS

A. Studs and Floor Track:

1. Basis-of-Design Product: Subject to compliance with requirements provide ClarkDietrich Building Systems; Prostud Series. **or a comparable product by one of the following:**
 - a. MarinoWARE.
 - b. SCAFCO Steel Stud Company.
2. Minimum Base-Steel Thickness: 30 mil.
3. Minimum Steel Strength: Minimum Yield Strength of 33 ksi.
4. Depth: As indicated on Drawings.

B. Embossed (EQ), High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.

1. Basis-of-Design Product: Subject to compliance with requirements provide ClarkDietrich Building Systems; Prostud Series **or a comparable product by one of the following:**
 - a. MarinoWARE.
 - b. SCAFCO Steel Stud Company.
2. Steel Strength: Minimum Yield Strength of 50 ksi.
3. Minimum Base Steel Thickness: 18 mil; 20 gage equivalent.
4. EQ Steel Studs and Tracks are not allowed as framing members that receive:
 - a. Abuse-Resistant Gypsum Board.
 - b. Impact-Resistant Gypsum Board.
 - c. Tile Backing Panel.
 - d. Where prohibited on Drawings.
5. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide the following as indicated on Drawings:

1. Single Long-Leg Track System: ASTM C645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 - a. Basis-of-Design Product: Subject to compliance with requirements, Clark Dietrich Building Systems; Deep Leg Deflection Track **or a comparable product by one of the following:**
 - 1) SCAFCO Steel Stud Company.
2. Slotted Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Basis-of-Design Product: Subject to compliance with requirements, ClarkDietrich Building Systems; MaxTrack **or a comparable product by one of the following:**
 - 1) SCAFCO Steel Stud Company.
 - b. Provide assemblies as shown on Drawings.

3. Offset Shoulder Deflection Track: Steel sheet top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Basis-of-Design Product: Subject to compliance with requirements, ClarkDietrich Building Systems; BlazeFrame RipTrack Series 2 and 4, as indicated on Drawings per the indicated UL assembly **or a comparable product by the following:**
 - 1) Fire Trak Corporation.
- D. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 1. Products: Subject to compliance with requirements, provide track products by the manufacturer providing framing systems.
 2. Minimum Base-Steel Thickness: As indicated on Drawings.
 3. Depth: As indicated on Drawings.
- E. Z-Shaped Furring: With slotted or non-slotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.
 1. Products: Subject to compliance with requirements, provide track products by the manufacturer providing framing systems.
 2. Minimum Base-Steel Thickness: As indicated on Drawings.
 3. Depth: As indicated on Drawings.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 092400 - CEMENT PLASTERING

GUIDELINES

1. *Coordinate plaster assemblies with continuous insulation requirements and substrate weather barrier assembly. Select insulation based on Title 24 Part 6 energy code compliance.*
2. *Spec is based on TSIB recommendations. As a crack control method for smooth finishes, Section also includes a base coat applied over the brown coat to embed reinforcing mesh.*
3. *Provided thermally broken clip such as Knightwall ThermaZee for lath attachment. Coordinate with insulation thickness.*
4. *Specification is based on acrylic finish coat for water resistance and color performance. Coordinate color with District Design Guide Standards.*
5. *Preconstruction conferences are critical for coordination.*
6. *Coordinate final finish coat texture with District.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Metal lath.
 2. Base-coat cement plaster.
 3. Cement plaster finish coats.
 4. Accessories.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain plaster materials from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements:
 1. Adhesives, sealants, and coatings: Comply with SCAQMD VOC content and VOC emissions as required.
- B. Fire-Resistance Ratings: Where indicated, provide cement plaster assemblies identical to those of assemblies tested for fire resistance according to ASTM E119 by a qualified testing agency.

2.3 METAL LATH

- A. Welded Wire Lath: ASTM C 933, self-furring, cold-rolled carbon-steel wire sheet with ASTM A 653/A 653M, G60, hot-dip galvanized-zinc coating.
 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. Structawire or equal.
 2. Series: MegaLath.
 3. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
 4. Weight: Self-furring, 1.95 lb./sq. yd.
 5. Approval: IAPMO UES 2017
 6. Paper backed lath not acceptable.

CEMENT PLASTERING

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- B. Welded Wire Lath at Soffits: ASTM C 933, self-furring, cold-rolled carbon-steel wire sheet with ASTM A 653/A 653M, G60, hot-dip galvanized-zinc coating.
 - 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. Structawire or equal.
 - 2. Series: SWC V Truss.
 - 3. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
 - 4. Panel Weight: Self-furring, 2.2 lb./sq. yd.
 - 5. Approval: IAPMO UES 2017
 - 6. Paper backing: Manufacturers perforated kraft paper.
- C. Plaster underlayment: Fortifiber Super Jumbo Tex 60 Minute or equal,
 - 1. Type: FS UU-B-790, Type I Grade D, Style 2 vapor-permeable paper, minimum 60-minute water resistance
 - 2. Approvals: ESR 1027
 - 3. NFPA 285 Compliance: Approved for use in NFPA 285 assemblies with continuous insulation.

2.4 BASE-COAT CEMENT PLASTER

- A. General: Comply with ASTM C926 for applications indicated.
 - 1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturers' written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. of cementitious materials.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
 - 1. Portland Cement Mixes: Provide mix meeting CBC requirements.
- C. Base-Coat for embedment of reinforcing mesh, applied over brown coat.
 - 1. Portland Cement Mixes: Provide mix meeting finish coat manufacturers requirements.
 - 2. Reinforcing Mesh: 4 oz fiber glass, alkali resistant.

2.5 FINISH COAT

- A. Finish Coat: Provide acrylic finish coat.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:
 - a. Sto Corp. – Basis of Design
 - b. Dryvit Systems, Inc.
 - c. Senergy, BASF Wall Systems, Inc.
- B. Series: Stolit Essence.
- C. Characteristics
 - 1. Base Coat Primer: Manufacturer Basis of Design Product: Subject to compliance with requirements, provide manufacturers product as follows:
 - a. Sto Acrylic Primer for fully cured (minimum 28 days old or pH less than 10) stucco surfaces.
 - 1) Surface Burning, ASTM E 84: Flame Spread less than 25, Smoke Developed less than 450, Class A building material
 - 2) VOC: less than 50 g/L, compliant with South Coast AQMD Rule 1113 for architectural coatings

2. Fire Resistivity:
 - a. Flame Spread: Maximum 25 value per ASTM E 84.
 - b. Smoke Developed: Maximum value 450 per ASTM E 84.
3. Finish Coat Color:
 - a. Color: As selected by Architect.

2.6 ACCESSORIES

- A. General: Comply with ASTM C1063, and coordinate depth of trim and accessories with thickness and number of plaster coats required.
- B. Metal Accessories:
 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. Stockton
 - b. Brand X Metals, Inc.
 - c. CEMCO; California Expanded Metal Products Co.
 2. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A653/A653M, [G60][G90] zinc coating.
 - a. Stockton Products' weep screed #7 or equal.
 - b. Stockton Products' weep screed #36 or equal.
 3. Cornerite: Fabricated from metal lath with ASTM A653/A653M, [G60][G90], hot-dip galvanized-zinc coating.
 4. External- (Outside-) Corner Reinforcement: Fabricated from metal lath with ASTM A653/A653M, , hot-dip galvanized-zinc coating.
 5. Cornerbeads: Fabricated from **zinc-coated (galvanized)** [G60][G90] steel.
 - a. Smallnose cornerbead with expanded flanges; use unless otherwise indicated.
 - b. Smallnose cornerbead with perforated flanges; use on curved corners.
 - c. Smallnose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.
 - d. Bullnose cornerbead, radius 3/4 inch minimum, with expanded flanges; use at locations indicated on Drawings.
 6. Casing Beads: Fabricated from ; square-edged style; with expanded flanges.
 - a. Cemco's 7/8-inch, J-8 (non-perforated), 3-1/2 inch flange, or equal
 7. Control Joints: Fabricated from **or** ; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
 - a. Cemco, "XJ-15", or equal
 8. Drift Joint: Fabricated from zinc-coated (galvanized) **[G60][G90]** steel formed to produce drift / slip-joint and square-edged reveal; with perforated flanges
 - a. Cemco; Horizontal M-slide expansion joint, MSX, or equal.
 9. Soffit Drip Screed: Fabricated from **zinc-coated (galvanized)** [G60][G90] steel; non-perforated 2-1/2 inch minimum leg
 - a. Cemco; 5, NFD, or equal.

10. Head Drip Screed: Fabricated from **zinc-coated (galvanized)** [G60][G90] steel; non-perforated 2-1/2-inch minimum leg
 - a. Cemco; #5 Drip, or equal.
 11. Two-Piece Expansion Joints: Fabricated from **zinc-coated (galvanized)** [G60][G90] steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch wide; with perforated flanges.
- C. Plastic Accessories: Manufactured from high-impact PVC.
1. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged [1/2-inch-] [1-inch-] [1-1/2-inch-] **<Insert dimension>** wide reveal; with perforated concealed flanges.
- D. Aluminum Metal Accessories: Extruded accessories of profiles and dimensions indicated.
1. Manufacturers: Where aluminum profiles are indicated, and subject to compliance with requirements, provide products by one of the following or equal:
 - a. Fry Reglet Corp.
 - b. Gordon, Inc.
 - c. Pittcon Industries.
 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, alloy 6063-T5.
 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.
 4. Profiles:
 - a. Channel Screed – 1 /4 inch: Fry PCS-75-25/25.
 - b. Channel Screed – reveal width as shown – CJ-2: Fry PCS-75-XX
 - c. Reveal Edge – F Profile, reveal width as shown: Fry FDM-75-XX.
 - d. Reveal Edge – T Profile, reveal width as shown: Fry TRM-75-XX.
 - e. Plaster J-Molding Casing Edge: Fry JPM-75.
 - f. Plaster J-Molding Drip Edge: Fry JPM-75, perforated.
 - g. Plaster soffit vent: Fry PCS-75-V-100.
 5. Transitions and Intersections
 - a. Provide stretch formed, factory curved elements at all radius conditions.
 - b. Provide factory fabricated three- and four-way intersections, with attachment clips.
- 2.7 MISCELLANEOUS MATERIALS
- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
 - B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch long, free of contaminants, manufactured for use in cement plaster.
 - C. Bonding Compound: ASTM C932.
 - D. Fasteners for Attaching Metal Lath to Substrates: ASTM C1063.
 - E. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter unless otherwise indicated.

PART 3 - EXECUTION – NOT USED

END OF SECTION

CEMENT PLASTERING

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SECTION 092900 - GYPSUM BOARD

GUIDELINES

1. *Specification includes provisions for gypsum board installation prior to enclosure. This may expose gypsum board shafts, perimeter walls and other assemblies to moisture damage. See HCAI CAN -2-2508 for guidance.*
2. *Most District projects will require DSA review, and not use delegated design. Where project allows delegated design, establish appropriate load and deflection criteria in coordination with Section 092216.*
3. *Establish appropriate deflection values for acoustic and fire rated head of wall conditions.*
4. *Coordinate elevator shaft wall cants and offset dimensions with California Title 8 elevator code.*
5. *Designate acoustic and fire ratings for each shaft wall application on drawings.*
6. *Coordinate tile backing panel selection with tile sections.*
7. *Consider mockups, with final finish, to confirm appropriate gypsum board Finish Levels.*
8. *Review use of District suggested drywall textured coatings such as orange peel or knockdown finish.*
9. *Review control joint criteria per ASTM C 840 and show on drawings.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Interior gypsum board.
 2. Tile backing panels.
 3. Texture finishes

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
 1. Marking Fire-Resistance-Rated Assemblies: Where accessible concealed fire-resistance-rated wall assemblies occur, apply hourly rating text in 3 inch high red numbers and black Arial font letters, 3 /8 inch stroke, all capitals. Locate within 15 feet of the end of each wall and at intervals not exceeding 30 feet measured from beginning of one text application to end of next text application. Place text 6 inches above finished ceiling to bottom of text. Provide following hourly rating text as applicable to wall:
 - a. 1 HR FIRE RATED - PROTECT ALL OPENINGS
 - b. 2 HR FIRE RATED - PROTECT ALL OPENINGS
 - c. 3 HR FIRE RATED - PROTECT ALL OPENINGS
 - d. 4 HR FIRE RATED - PROTECT ALL OPENINGS
 - e. 1 HR Fire/Smoke RATED - PROTECT ALL OPENINGS
 - f. 2 HR Fire/Smoke RATED - PROTECT ALL OPENINGS
 - g. SMOKE BARRIER - PROTECT ALL OPENINGS

- B. Moisture Control: Do not install interior products until installation areas are enclosed and conditioned including, but not limited to, the following general minimum parameters for paper-faced gypsum board and finishing compounds:
 - 1. Surfaces exposed to weather, including:
 - a. Shafts and unprotected openings in horizontal surfaces directly exposed to snow, water, dew or condensation.
 - b. Walls within a horizontal distance from an exterior opening of two times the height of the exterior opening.
 - 2. No visible water sources in contact with gypsum board.
 - 3. Minimum 40 degrees F for gypsum board installation.
 - 4. Minimum 50 degrees F throughout finishing process including compound drying time.
 - 5. Building ventilation sufficient to allow compound to dry within 10 hours.
 - 6. When the Contractor's proposed construction schedule or construction conditions indicates paper faced gypsum board will be installed in conflict with specified requirements, comply with the following:
 - a. Provide glass mat gypsum sheathing board in lieu of paper faced gypsum board meeting specified performance requirements and assembly criteria.
 - b. Provide Informational submittal showing glass mat gypsum sheathing board locations.
- C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels providing substrate for tile.
 - 3. Level 3: Where indicated on Drawings.
 - 4. Level 4: At panel surfaces receiving flat paint, wall coverings, that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
 - 5. Level 5: At Panel surfaces receiving graphic films, gloss and semi-gloss paints.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Control Joints: Install control joints according to ASTM C 840 at locations indicated on Drawings.

2.3 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. 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. Georgia-Pacific Gypsum LLC.
 - 2. National Gypsum Company.
 - 3. PABCO Gypsum.
 - 4. USG Corporation.

2.4 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C1396/C1396M.
 - 1. Thickness: 1/2 inch.
 - 2. Long Edges: Tapered.
- B. Gypsum Board, Type X: ASTM C1396/C1396M.
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
- C. Flexible Gypsum Board: ASTM C1396/C1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
 - 1. Thickness: 1/4 inch.
 - 2. Long Edges: Tapered.
- D. Flexible Gypsum Board Type X at Fire Rated assemblies: ASTM C 1396/C 1396M. Listed for use in fire rated assemblies, and manufactured to bend to fit radii indicated on drawings.
 - 1. Core: Type X.
 - 2. Thickness: 5/16 inch.
 - 3. Long Edges: Tapered.
 - 4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- E. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M. Manufactured to produce greater resistance to surface indentation, through-penetration (impact resistance), and abrasion than standard, regular-type and Type X gypsum board.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers
 - 2. Core: 5/8 inch, Type X.
 - 3. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
 - 4. Surface Indentation: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
 - 5. Single-Drop Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 2 requirements.
 - 6. Long Edges: Tapered.
 - 7. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- F. Impact-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.
 - 1. Core: 5/8 inch, Type X.
 - 2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 2 requirements.
 - 3. Surface Indentation: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
 - 4. Single-Drop Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
 - 5. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements for single layer application or Level 2 requirements for double layer application according to test in Annex A1.
 - 6. Long Edges: Tapered.
 - 7. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- G. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
 - 1. Core: As indicated on Drawings.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 SPECIALTY GYPSUM BOARD

- A. Glass-Mat Interior Gypsum Board: ASTM C1658/C1658M, fiberglass mat laminated to both sides, specifically designed for interior use.
 - 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. Georgia-Pacific Gypsum LLC.
 - b. National Gypsum Company.
 - c. PABCO Gypsum.
 - d. USG Corporation.
 - 2. Core: As indicated on Drawings.
 - 3. Long Edges: Tapered.
 - 4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- B. Acoustically Enhanced Gypsum Board: ASTM C1766. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.
 - 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. Certainteed; SAINT-GOBAIN.
 - b. National Gypsum Company.
 - c. PABCO Gypsum.
 - 2. Core: As indicated on Drawings.
 - 3. Long Edges: Tapered.

2.6 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
 - 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. Certainteed; SAINT-GOBAIN.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 - 2. Core: As indicated on Drawings.
 - 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- B. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.
 - 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. Certainteed; SAINT-GOBAIN.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 - 2. Core: As indicated on Drawings.

2.7 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.

2.8 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
- D. Joint Compound for Tile Backing Panels:
 - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
 - 2. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.9 TEXTURE FINISHES

- A. Primer: As recommended by textured finish manufacturer.
- B. Non-Aggregate Finish: Premixed, vinyl texture finish for spray application.
 - 1. Manufacturers:
 - a. Certaineed; SAINT-GOBAIN.
 - b. National Gypsum Company.
 - c. USG Corporation.
 - 2. Texture: Light Orange peel.

2.10 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- B. Products: Subject to compliance with requirements, provide the following:
 - 1. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
 - 2. Franklin International; Titebond GREENchoice Professional Acoustical Smoke & Sound Sealant.
 - 3. Grabber Construction Products; Acoustical Sealant GSC.
 - 4. Hilti, Inc.; CP 506 Smoke and Acoustical Sealant.
 - 5. Pecora Corporation; AC-20 FTR or AIS-919.
 - 6. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
- C. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

2.11 SOUND ATTENUATION BLANKETS

- A. Sound Attenuation Blankets: ASTM C665, Type I; unfaced glass fiber batts, blankets, or rolls; minimum fire hazard classification rating of 25/50 per ASTM E84; thickness as indicated on Drawings to meet acoustical requirements; widths to friction-fit between studs, where indicated for installation in stud walls; formaldehyde free.

2.12 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 093000 - TILING

GUIDELINES

1. *Specify appropriate installation method for application and function. Thinset methods do not afford slope capability.*
2. *Recommend use of full crack isolation system at all conditions unless waterproofed system required.*
3. *Coordinate tile size with floor level tolerances as required by TCNA. Use of oversize tiles and thinset method can result in lippage issues. Minimum tile size is 8 inches x 8 inches to minimize joints. Unless required by health department, do not use coved tile base.*
4. *Use of epoxy grout strongly recommended for durability and water resistance.*
5. *Show expansion joint locations on drawings.*
6. *Slip resistance requires careful selection on test standard and values. Static testing value of 0.50 typically used by UL/OSHA should not be considered safe. Require dynamic testing (DCOF) using either ASTM E303 Pendulum Test or ANSI A326.3 initiated by TCNA. Pendulum test provides more discrete categories, and is used in all other countries except US. If ANSI A326.3 is used, standard includes "Declared Use Classification" values as reported by ceramic tile manufacturers. Values indicated in this document are options – select as appropriate. Field testing of completed work recommended.*
7. *Tile selection is typically indicated in a Finish Legend on the drawings. Coordinate selection with specified technical criteria, particularly DCOF.*
8. *Use metal edge trims, including at floor transitions. Do not use stone or marble threshold transitions.*

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceramic tiling, including, but not limited to, the following:
 - a. Ceramic mosaic tile.
 - b. Quarry tile.
 - c. Pressed (cushion edge) floor tile.
 - d. Porcelain tile.
 - e. Glazed wall tile.
 - f. Waterproof membrane.
 - g. Crack isolation membrane.
 - h. Metal edge strips.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- ##### A. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
 2. Obtain waterproof membrane crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.

2.2 PRODUCTS, GENERAL

- A. Sustainable Design Requirements:
 - 1. Adhesives, sealants, and coatings: Comply with SCAQMD VOC content and VOC emissions as required.
- B. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements **unless otherwise indicated**.
- C. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- D. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- E. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
 - 1. Where tile is indicated for installation in swimming pools, on exteriors or in wet areas, do not use back or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
- F. Slip Resistance Characteristics: For tile flooring products, as determined by published testing reports provided by tile manufacturer.
 - 1. Dynamic Coefficient of Friction (COF AcuTest, ANSI A326.3): Not less than the following:
 - a. Interior, Wet (IW): Level Surfaces: **[0.42.]**[0.60]
 - b. Interior, Wet Plus (IW+), Shower floors, Staff Lounges, ground floor lobbies: 0.65.
 - c. Exterior, Wet (EW), Level Surfaces: 0.65
 - d. Exterior and Interior ramps and inclines: Minimum 0.80.
 - e. Oils/Greases (O/G): Minimum 0.80.
 - 2. Dynamic Coefficient of Friction (DCOF), ASTM E 303 – Pendulum Test: Not less than the following:
 - a. Interior, Level Surfaces: Minimum 36.
 - b. Interior Shower floors, Staff Lounges, ground floor lobbies: Minimum 36.
 - c. Exterior, Level Surfaces: Minimum 45
 - d. Serving areas, swimming pool surrounds, locker room shower rooms: Minimum 45
 - e. Exterior and Interior ramps and inclines: Minimum 54.
 - f. Oils/Greases, commercial kitchens: Minimum 54.

2.3 CERAMIC TILE PRODUCTS

- A. Ceramic Mosaic Tile Type <**Enter Finish Legend designation**>: Factory-mounted **[unglazed]** **[glazed]** ceramic mosaic tile.
 - 1. Product: Subject to compliance with performance requirements, provide product indicated on Drawings.
- B. Quarry Tile Type <**Enter designation**>: **[Unglazed]** **[Glazed]** square-edged quarry tile.
 - 1. Product: Subject to compliance with performance requirements, provide product indicated on Drawings.
- C. Pressed (Cushion Edge) Floor Tile Type <**Enter designation**>: **[Unglazed]** **[Glazed]** pressed floor tile.

1. Product: Subject to compliance with performance requirements, provide product indicated on Drawings:
- D. Porcelain Tile Type <Enter designation>: [Unglazed] [Glazed] porcelain tile.
 1. Product: Subject to compliance with performance requirements, provide product indicated on Drawings.
- E. Glazed Wall Tile Type <Enter designation>: Glazed wall tile.
 1. Product: Subject to compliance with performance requirements, provide product indicated on Drawings.
- F. Waterproof Membrane
 1. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
 2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Noble Company (The); Nobleseal TS.
 - b. Nominal Thickness: 0.040 inch.
 3. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Custom Building Products; RedGard Waterproofing and Crack Prevention Membrane.
- G. Crack Isolation Membrane
 1. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
 2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.
 - a. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
 - 1) Noble Company (The); Nobleseal CIS.
 3. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
 - a. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
 - 1) Custom Building Products; RedGard Waterproofing and Crack Prevention Membrane.
- H. Setting Materials
 1. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
 - a. Cleavage Membrane: Asphalt felt, ASTM D 226/D 226M, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils thick.
 - b. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A 185/A 185M and ASTM A 82/A 82M, except for minimum wire size.

- c. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C 847.
 - 1) Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
 - 2) Weight: 3.4 lb/sq. yd..
 - d. Latex Additive: Acrylic resin water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
2. Dry-Set Portland Cement Mortar (Thinset): ANSI A118.1.
- 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) Ardex Americas.
 - 2) Custom Building Products.
 - 3) LATICRETE SUPERCAP, LLC.
 - 4) MAPEI Corporation.
 - b. Product: Subject to compliance with requirements, provide product indicated on Drawings.
 - c. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.
3. Latex-Portland Cement Mortar (Thinset): ANSI A118.4.
- 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) Ardex Americas.
 - 2) Custom Building Products.
 - 3) LATICRETE SUPERCAP, LLC.
 - 4) MAPEI Corporation.
 - b. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - c. Provide prepackaged, dry-mortar mix combined with acrylic resin liquid-latex additive at Project site.
 - d. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
4. Dry Set Mortar for Large and Heavy Tile (LHT), Latex-Portland Cement Mortar: Comply with requirements in TCNA Handbook for Ceramic, Glass, and Stone Tile Installation. Provide product that is approved by manufacturer for application thickness of [5/8 inch] **<Insert thickness>**.
- 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) Ardex Americas.
 - 2) Custom Building Products.
 - 3) LATICRETE SUPERCAP, LLC.
 - 4) MAPEI Corporation.
 - b. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.

- c. Provide prepackaged, dry-mortar mix combined with acrylic resin liquid-latex additive at Project site.
- 5. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.
 - 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:**
 - b. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings :
 - 1) Custom Building Products.
 - 2) LATICRETE SUPERCAP, LLC.
 - 3) MAPEI Corporation.
 - c. Adhesives shall have a VOC content of **[65] <Insert value>** g/L or less.
 - d. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - e. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F (60 and 100 deg C), respectively, and certified by manufacturer for intended use.
- I. Grout Materials
 - 1. Water-Cleanable Epoxy Grout: ANSI A118.3[, **with a VOC content of 65 g/L or less**].
 - 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) Custom Building Products.
 - 2) LATICRETE SUPERCAP, LLC.
 - 3) MAPEI Corporation.
 - b. Product: Subject to compliance with requirements, provide product indicated on Drawings.
 - c. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F (60 and 100 deg C), respectively, and certified by manufacturer for intended use.
- J. Miscellaneous Materials
 - 1. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
 - 2. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D 4397, 4.0 mils thick.
 - 3. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; **[white zinc alloy] [nickel silver] [stainless-steel, ASTM A 666, 300 Series]** exposed-edge material.
 - 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) Ceramic Tool Company, Inc.
 - 2) Schluter Systems L.P.

- b. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- 4. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- 5. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
 - a. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
 - 1) Custom Building Products; Surfaceguard Sealer.
 - b. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

2.5 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Expansion Joint:
 - 1. Floor and wall conditions: Provide sealant expansion joints at specified conditions.
 - a. Tile Installation: TCNA EJ 171, including referenced graphics.
 - 1) Tile Type: As indicated on Finish Legend.
 - 2) Sealant: Urethane matching grout color as specified in Section 079200.
 - b. Floor Tile at Expansion Joint: TCNA EJ 171C
 - c. Wall Tile Interior Corner: EJ171(I)
 - d. Wall Tile abutting ceiling or ceiling trim surface: EJ171(I)
 - e. Wall Tile to Floor Tile: Sealant joint at floor tile to specified metal transition.
- B. Interior Floors, Concrete Subfloor:
 - 1. Thickset Installations:
 - a. Ceramic Tile Installation <Insert designation>: TCNA F111 and [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]; cement mortar bed (thickset) with cleavage membrane.
 - 1) Ceramic Tile Type: <Insert tile-type designation>.
 - 2) Bond Coat for Cured-Bed Method: Dry-set Latex- LHT, latex- portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout..
 - b. Ceramic Tile Installation <Insert designation>: TCNA F121 and [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]; cement mortar bed (thickset) on waterproof membrane.
 - 1) Ceramic Tile Type: <Insert tile-type designation>.

- 2) Bond Coat for Cured-Bed Method: Dry-set Latex- LHT, latex- portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout.
 2. Thinset Installations:
 - a. Ceramic Tile Installation **<Insert designation>**: TCNA F113; thinset mortar.
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Thinset Mortar: Dry-set Latex- LHT, latex- portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout.
 - b. Ceramic Tile Installation **<Insert designation>**: TCNA F122; thinset mortar on waterproof membrane.
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Thinset Mortar: Latex- LHT, latex- portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout..
 - c. Ceramic Tile Installation **<Insert designation>**: TCNA F125-Full; thinset mortar on crack isolation membrane.
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Thinset Mortar: Latex- LHT, latex- portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout.
- C. Interior Walls, Masonry or Concrete:
 1. Thinset Installations:
 - a. Ceramic Tile Installation Thinset **<Insert designation>**: TCNA W202E; thinset mortar.
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Thinset Mortar: Dry-set Latex- LHT, latex- portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout.
 2. Thickset Installations:
 - a. Ceramic Tile Installation **<Insert designation>**: TCNA W211 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) bonded to substrate.
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Bond Coat for Wet-Set Method: Dry-set Latex- portland cement mortar.
 - 3) Bond Coat for Cured-Bed Method: Dry-set Latex- portland cement mortar.
 - 4) Grout: Water-cleanable epoxy grout.
- D. Interior Walls, Metal Studs or Furring:
 1. Thickset Installations:
 - a. Ceramic Tile Installation **<Insert designation>**: TCNA W231/W241 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset).
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Bond Coat for Wet-Set Method: Dry-set Latex- portland cement mortar.
 - 3) Bond Coat for Cured-Bed Method: Dry-set Latex- portland cement mortar.
 - 4) Grout: Water-cleanable epoxy grout..

2. Thinset Installations:

- a. Ceramic Tile Installation **<Insert designation>**: TCNA W243; thinset mortar on gypsum board.
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Thinset Mortar: Dry-set Latex- portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout.
- b. Ceramic Tile Installation **<Insert designation>**: TCNA W244C or TCNA W244F; thinset mortar on cementitious backer units or fiber-cement backer board .
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Thinset Mortar: Dry-set Latex- portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout.
- c. Ceramic Tile Installation **<Insert designation>**: TCNA W245 or TCNA W248; thinset mortar on glass-mat, water-resistant gypsum backer board.
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Thinset Mortar: **[Dry-set]** **[Latex-]** portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout.

E. Shower Receptor Wall Installations:

1. Thinset Installations

- a. Ceramic Tile Installation **<Insert designation>**: TCNA B415; water-cleanable, tile-setting epoxy on waterproof membrane over cementitious backer units or fiber-cement backer board. Coordinate with shower receptor floor waterproofing.
 - 1) Ceramic Tile Type: **<Insert tile-type designation>**.
 - 2) Thinset Mortar: **[Dry-set]** **[Latex-]** portland cement mortar.
 - 3) Grout: Water-cleanable epoxy grout.

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

GUIDELINES

1. *Coordinate spec with detailed DSA suspended ceiling requirements, including suspension wires, compression struts, and edge restraint conditions. Use of these requirements is recommended for non-DSA projects.*
2. *Use of seismic grid clips, such as BERC clips, requires DSA approval. Show on drawings and specify.*
3. *Consider suspension corrosion resistance at laundry rooms, janitors closets and similar spaces. Kitchens should avoid suspended acoustical panel ceilings in favor of continuous gypsum board ceilings*
4. *District prefers Tegular type panel edge to minimize grid quality issues.*
5. *Panel selection is typically indicated in a Finish Legend on the drawings. Coordinate selection with specified technical criteria, particularly acoustical and surface finish.*
6. *Acoustical panel options are extensive, and include low carbon, energy use reduction, high acoustical performance, and other specialty finishes. Select panel appropriate to function and project objectives.*
7. *Review and apply CBC 1207.2 for ANSI S12.60 – 2020 enhanced classroom acoustical performance. Consider application without room volume scope exception allowed by code.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7 as modified by CBC Chapter 16A**.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: Class A according to ASTM E 1264.
 2. Smoke-Developed Index: 450 or less.
- C. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
- D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.3 ACOUSTICAL PANELS

- 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: Armstrong World Industries, Inc.
 - 2. CertainTeed Corporation.
 - 3. USG
- B. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- C. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.
- D. Panels: Made with binder containing no urea formaldehyde.
- E. Classification: Provide **fire-resistance-rated** panels as follows:
 - 1. Type and Form: <Insert per updated ASTM E1264-23 classification>.
- F. Color: **As indicated on Drawings.**
- G. Fire Resistance: Class A per ASTM E84, UL labeled.
- H. Light Reflectance (LR): Not less than <Insert LR.>
- I. Ceiling Attenuation Class (CAC): Not less than **Insert CAC.**
- J. Noise Reduction Coefficient (NRC): Not less than <Insert NRC.>
- K. Articulation Class (AC): Not less than <Insert AC.>
- L. Edge/Joint Detail: **[Square][Tegular]**
- M. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEM <Insert drawing designation>

- A. Manufacturers:
 - 1. Armstrong World Industries, Inc.
 - 2. Chicago Metallic Corporation.
 - 3. United States Gypsum Company.
- B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, heavy duty metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.
 - 1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classified Severe Environment Performance" where high-humidity finishes are indicated.
- C. Narrow face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 9/16-inch-wide metal caps on flanges.
 - 1. Ceiling Grid Series: Armstrong Silhouette XL 1/8-inch Reveal, or equal
 - 2. Acoustical Panel Ceiling Type: As indicated in Finish Legend on Drawings.
 - 3. Structural Classification: Heavy-duty system.
 - 4. End Condition of Cross Runners: butt-edge type.

ACOUSTICAL PANEL CEILINGS

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5. Face Design: Flat, flush, with 1/8 slot.
 6. Cap Material: Cold-rolled steel or aluminum.
 7. Cap Finish: Painted white.
- D. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized, G30coating designation; with prefinished 15/16-inch-wide metal caps on flanges.
1. Acoustical Panel Ceiling Type: As indicated in Finish Legend on Drawings.
 2. Structural Classification: Heavy-duty system.
 3. End Condition of Cross Runners: butt-edge type.
 4. Face Design: Flat, flush.
 5. Cap Material: Cold-rolled steel or aluminum.
 6. Cap Finish: Painted white.

2.6 METAL EDGE MOLDINGS AND TRIM <Insert drawing designation>

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
 2. For lay-in panels with reveal edge details, provide <Insert description>.
 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
 2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
 3. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils . Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - a. Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 096513 - RESILIENT BASE AND ACCESSORIES

GUIDELINES

1. *District prefers prefer preformed outside corners and coped inside corners. Suggest sample review to verify color consistency with running base and preformed corner.*
2. *Specify method for dealing with preformed corners at non – 90 degree conditions.*
3. *Base selection is typically indicated in a Finish Legend on the drawings. Coordinate selection with specified technical criteria.*
4. *Resilient base options are extensive, including profiles intended to mimic wood moldings. Select type appropriate to function and project objectives.*
5. *Verify code criteria for fire resistance and flame spread as a wall finish. Resilient base is typically Class B, not Class A per ASTM E84.*
6. *Avoid vinyl base to minimize shrinkage.*
7. *Consider use of rubber stair treads, risers and skirting at metal stairs for noise reduction and integral contrasting strip.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Thermoset-rubber base.
 2. Thermoplastic-rubber base.
 3. Rubber molding accessories.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements:
1. Adhesives, sealants, and coatings: Comply with SCAQMD VOC content and VOC emissions as required.

2.2 THERMOSET-RUBBER BASE <Insert drawing designation>

- A. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
1. Style and Location:
 - a. Style A, Straight: **Provide in areas with carpet.**
 - b. Style B, Cove: **Provide in areas with resilient floor coverings and other hard surface finishes.**
 - c. Style C, Butt to: **Provide in areas indicated.**
 - d. Style D, Sculptured: **Provide in areas indicated.**
 - B. Thickness: 0.125 inch.
 - C. Height: **As indicated on Drawings.**
 - D. Lengths: **Coils in manufacturer's standard length.**
 - E. Outside Corners: **[Preformed][Job Formed].**

- F. Inside Corners: **Job formed.**
- G. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm..
- H. Colors: As indicated by manufacturer's designations.

2.3 THERMOPLASTIC-RUBBER BASE <Insert drawing designation>

- 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. Burke Mercer Flooring Products; a division of Burke Industries Inc.
 - 2. Flexco.
 - 3. Johnsonite; A Tarkett Company.
 - 4. Nora Systems, Inc.
 - 5. Roppe Corporation, USA.
 - 6. Insert manufacturer's name.
- B. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- C. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
 - 1. Group: **I (solid, homogeneous).**
 - 2. Style and Location:
 - a. Style A, Straight: **Provide in areas with carpet.**
 - b. Style B, Cove: **Provide in areas with resilient floor coverings and other hard surface finishes.**
 - c. Style C, Butt to: Provide in areas indicated.
 - d. Style D, Sculptured: Provide in areas indicated.
- D. Thickness: 0.125 inch.
- E. Outside Corners: **[Preformed][Job Formed].**
- F. Inside Corners: **Job formed.**
- G. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm..
- H. Colors: **As indicated by manufacturer's designations.**

2.4 RUBBER MOLDING ACCESSORY <Insert drawing designation>

- A. Profile and Dimensions: **As indicated.**
- B. Locations: **Provide rubber molding accessories in areas indicated.**
- C. Colors and Patterns: **As indicated by manufacturer's designations.**

2.5 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Metal Edge Strips: [Aluminum][stainless steel], nominal 2 inches wide, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 096516 - RESILIENT SHEET FLOORING

GUIDELINES

- 1. Use of resilient sheet flooring requires prior District approval. May be appropriate for certain wet areas. If used, provide heat welded seams.*
- 2. Slip resistance requires careful selection on test standard and values. Testing under ASTM D 2047 is not designed for DCOF conditions. Static testing value of 0.50 typically used by UL/OSHA should not be considered safe. Require dynamic testing (DCOF) using either ASTM E303 Pendulum Test or ANSI A326.3 initiated by TCNA. Pendulum test provides more discrete categories, and is used in all other countries except US. If ANSI A326.3 is used, note that resilient flooring manufacturers do not report "Declared Use Classification" values as reported by ceramic tile manufacturers. Values indicated in this document are options – select as appropriate. Field testing of completed work recommended.*
- 3. Flooring selection is typically indicated in a Finish Legend on the drawings. Coordinate selection with specified technical criteria, particularly DCOF.*
- 4. Coordinate adhesive selection with application and slab moisture considerations. Consider use of high performance adhesives such as Taylor Resolute with high moisture resistance warranty.*
- 5. Review maintenance procedures with District and specify waxing or polishing as appropriate.*

PART 1 - GENERAL

- A. Section Includes:
1. Resilient sheet rubber flooring.
 2. Resilient linoleum flooring.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements:
1. Adhesives, sealants, and coatings: Comply with SCAQMD VOC content and VOC emissions as required.
- B. Slip Resistance Characteristics: For flooring products, as determined by published testing reports provided by tile manufacturer.
1. Dynamic Coefficient of Friction (COF AcuTest, ANSI A326.3): Not less than the following:
 - a. Interior, Wet (IW): Level Surfaces: [0.42][0.60].
 - b. Interior, Wet Plus (IW+), Shower floors, Staff Lounges, ground floor lobbies: 0.65.
 - c. Interior ramps and inclines: Minimum 0.80.
 - d. Oils/Greases (O/G): Minimum 0.80.
 2. Dynamic Coefficient of Friction (DCOF) ASTM E 303: Not less than the following:
 - a. Interior, Level Surfaces: Minimum 36.
 - b. Interior Shower floors, Staff Lounges, ground floor lobbies: Minimum 36.
 - c. Serving areas, swimming pool surrounds, locker room shower rooms: Minimum 45
 - d. Interior ramps and inclines: Minimum 54.
 - e. Oils/Greases, commercial kitchens: Minimum 54.
- C. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 UNBACKED VINYL SHEET FLOORING <Insert drawing designation>

- A. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- B. Product Standard: ASTM F 1913.
- C. Thickness: [0.080 inch] <Insert dimension>.
- D. Wearing Surface: Smooth.
- E. Seaming: Heat welded.
- F. Sheet Width: As standard with manufacturer.

2.3 VINYL SHEET FLOORING WITH BACKING <Insert drawing designation>

- A. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- B. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- C. Product Standard: ASTM F 1913.
- D. Thickness: [0.080 inch] <Insert dimension>.
- E. Wearing Surface: Smooth.
- F. Seaming: Heat welded.
- G. Sheet Width: As standard with manufacturer.

2.4 RUBBER SHEET FLOORING <Insert drawing designation>

- A. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- B. Product Standard: ASTM F 1860.
 - 1. Type: Type I, homogeneous rubber sheet floor covering.
 - 2. Overall Thickness: <Insert thickness>.
 - 3. Hardness: Manufacturer's standard hardness, measured using Shore, Type A durometer per ASTM D 2240.
- C. Thickness: [0.080 inch] <Insert dimension>.
- D. Wearing Surface: [Smooth] <Insert description>.
- E. Seaming: Heat welded.
- F. Sheet Width: As standard with manufacturer.

2.5 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.
 - 1. Provide adhesive forming slab moisture barrier up to 100 percent relative humidity per ASTM F2170 and pH value of 5-14.
 - 2. Provide urethane or epoxy adhesives at conditions subject to rolling loads.

PART 3 - EXECUTION – NOT USED

END OF SECTION

RESILIENT SHEET FLOORING

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SECTION 096519 - RESILIENT TILE FLOORING

GUIDELINES

1. District prefers resilient tile flooring.
2. Slip resistance requires careful selection on test standards and values. Testing under ASTM D 2047 is not designed for DCOF conditions. A static testing value of 0.50 typically used by UL/OSHA should not be considered safe. Require dynamic testing (DCOF) using either ASTM E303 Pendulum Test or ANSI A326.3 initiated by TCNA. Pendulum test provides more discrete categories and is used in all other countries except US. If ANSI A326.3 is used, note that flooring manufacturers do not report "Declared Use Classification" values as reported by ceramic tile manufacturers. Values indicated in this document are options – select as appropriate. Field testing of completed work recommended.
3. Flooring selection is typically indicated in a Finish Legend on the drawings. Coordinate selection with specified technical criteria, particularly DCOF.
4. With District approval, consider use of resilient tile plank flooring, referred to as "luxury vinyl flooring". Evaluate scratching characteristics. Apply using full spread adhesive.
5. Coordinate adhesive selection with application and slab moisture considerations. Consider use of high-performance adhesives such as Taylor Resolute with high moisture resistance warranty.
6. Review maintenance procedures with District and specify waxing or polishing as appropriate.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Rubber floor tile.
 2. Vinyl composition floor tile.
 3. Resilient terrazzo floor tile.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements:
1. Adhesives, sealants, and coatings: Comply with SCAQMD VOC content and VOC emissions as required.
- B. Slip Resistance Characteristics: For flooring products, as determined by published testing reports provided by flooring manufacturer.
1. Dynamic Coefficient of Friction (COF AcuTest, ANSI A326.3): Not less than the following:
 - a. Interior, Wet (IW): Level Surfaces: [0.42][0.60].
 - b. Interior, Wet Plus (IW+), Shower floors, Staff Lounges, ground floor lobbies: 0.65.
 - c. Interior ramps and inclines: Minimum 0.80.
 - d. Oils/Greases (O/G): Minimum 0.80.
 2. Dynamic Coefficient of Friction (DCOF) ASTM E 303: Not less than the following:
 - a. Interior Level Surfaces: Minimum 36.
 - b. Interior Shower floors, Staff Lounges, ground floor lobbies: Minimum 36.
 - c. Serving areas, swimming pool surrounds, locker room shower rooms: Minimum 45
 - d. Interior ramps and inclines: Minimum 54.
 - e. Oils/Greases, commercial kitchens: Minimum 54.

2.1 RUBBER FLOOR TILE <Insert drawing designation>

- A. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- B. Tile Standard: ASTM F 1344, [Class I-A, Homogeneous Rubber Tile, solid color] [Class I-B, Homogeneous Rubber Tile, through mottled].
- C. Hardness: [Grade 1, not less than the minimum hardness of 85 as required by ASTM F 1344] [Grade 2, minimum hardness of 70] [Manufacturer's standard hardness], measured using Shore, Type A durometer according to ASTM D 2240.
- D. Wearing Surface: [Smooth] [Textured] [Molded pattern].
 - 1. Molded-Pattern Figure: [Raised discs] [Raised squares] <Insert pattern>.
- E. Thickness: [0.125 inch] <Insert dimension>.
- F. Size: [12 by 12 inches] [24 by 24 inches] <Insert dimensions>.
- G. Seamless-Installation Method: Chemically bonded.
- H. Colors and Patterns: As indicated by manufacturer's designations.

2.2 SOLID VINYL FLOOR TILE <Insert drawing designation>

- A. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- B. Tile Standard: ASTM F 1700.
 - 1. Class: Class I, Monolithic Vinyl Tile.
 - 2. Type: A, Smooth Surface.
- C. Thickness: 0.080 inch.
- D. Colors and Patterns: As indicated by manufacturer's designations.

2.3 VINYL COMPOSITION FLOOR TILE **Insert drawing designation**

- A. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- B. Tile Standard: ASTM F 1066, Class 2, through pattern.
- C. Wearing Surface: Smooth.
- D. Thickness: 0.125 inches.
- E. Size: 12 by 12 inches.
- F. Colors and Patterns: **As indicated by manufacturer's designations.**

2.4 RESILIENT TERRAZZO FLOOR TILE <Insert drawing designation>

- A. Resilient Terrazzo Floor Tile: Marble or granite chips embedded in flexible, thermoset-polyester-resin matrix; electrically nonconductive and chemical, oil, and corrosion resistive, with smooth wearing surface and manufacturer's standard factory-applied, protective coating.
- B. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- C. Performance Characteristics:
 - 1. Abrasion Resistance: Maximum 0.0196-cu. cm volume loss, ASTM F 510, Taber abrader, S-39 wheels, at 500 cycles with 1000-gram load.

2.5 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.
 - 1. Provide adhesive forming slab moisture barrier up to 100 percent relative humidity per ASTM F2170 and pH value of 5-14.
 - 2. Provide urethane or epoxy adhesives at conditions subject to rolling loads.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 096813 - TILE CARPETING

GUIDELINES

1. *Manufacturers provide multiple carpet types, backings, and performance levels. Selection should reflect required function. See specified performance criteria and select carpet. Specify selected carpet characteristics.*
2. *Flooring selection is typically indicated in a Finish Legend on the drawings. Coordinate selection with specified technical criteria, particularly adhesives.*
3. *Coordinate adhesive selection with application and slab moisture considerations. Consider use of high performance adhesives such as Taylor Resolute with high moisture resistance warranty.*
4. *Specify tile orientation or pattern as recommended by Manufacturer.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Modular carpet tile.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements:
 1. Adhesives, sealants, and coatings: Comply with SCAQMD VOC content and VOC emissions as required.
- B. Performance Criteria:
 1. Appearance Retention Rating: **[Moderate traffic, 2.5] [Heavy traffic, 3.0] [Severe traffic, 3.5] <Insert number>** minimum according to ASTM D7330.
 2. Critical Radiant Flux Classification: Not less than **[0.45 W/sq. cm] [0.22 W/sq. cm]** according to NFPA 253.
 3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.
 4. Tuft Bind: Not less than **[3 lbf] [5 lbf] [6.2 lbf] [8 lbf] [10 lbf] <Insert value>** according to ASTM D1335.
 5. Delamination: Not less than **[3.5 lbf/in.] [4 lbf/in.] <Insert value>** according to ASTM D3936.
 6. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
 7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
 8. Noise Reduction Coefficient (NRC): **<Insert NRC>** according to ASTM C423.
 9. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
 10. Colorfastness to Light: Not less than 4 after **[40] [60] <Insert number>** AFU (AATCC fading units) according to AATCC 16, Option E.

2.2 CARPET TILE <Insert drawing designation>

- A. Product: Subject to compliance with requirements, provide product indicated on Drawings.
- B. Color: **As indicated by manufacturer's designations.**
- C. Fiber Type: **<Insert proprietary fiber type>.**

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- D. Stitches: **<Insert>** .
- E. Gage: **< Insert >**.
- F. Surface Pile Weight: **<Insert>** oz./sq. yd..
- G. Total Weight: **Insert** oz./sq. yd. for finished carpet tile.
- H. Primary Backing/Backcoating: **<Insert>**.
- I. Secondary Backing: **Manufacturer's standard material**.
- J. Backing System: **Insert proprietary name**.
- K. Size: [18 by 18 inches] [24 by 24 inches] [18 by 36 inches] [36 by 36 inches] **<Insert dimensions>**.
- L. Applied Treatments:
 - 1. Soil-Resistance Treatment: **Manufacturer's standard treatment**.
 - 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

2.3 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
 - 1. Provide adhesive forming slab moisture barrier up to 100 percent relative humidity per ASTM F2170 and pH value of 5-14.
- C. Metal Edge/Transition Strips: Extruded aluminum with finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 097200 - WALL COVERINGS

GUIDELINES

1. Consider use of polyolefin wall covering to avoid vinyl products.
2. Verify applicable fire testing based on wall covering type and CBC Chapter 8 criteria.
3. Use of wall covering as the backing for printed graphics is common. Coordinate graphic/digital requirements with manufacturer. Verify wallcovering with graphic printing meets type specified.
4. Coordinate gypsum wall Finish Level as required by wall covering manufacturer.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Vinyl wall covering.
 2. Thermoplastic-Polyolefin wall covering

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 2. Fire-Growth Contribution: No flashover and heat and smoke release according to [NFPA 286][NFPA 265].

2.2 WALL COVERING - < Insert Types >

- A. Product: Subject to compliance with performance requirements, provide product indicated on Drawings.
- B. Provide mildew-resistant vinyl coated products in rolls from same production run and complying with the following:
1. ASTM F 793: Type II Heavy Duty. Class A.
- C. Repeat: As indicated on drawings.
- D. Stain-Resistant Coating: Manufacturers standard coating.
- E. Colors, Textures, and Patterns: As shown on Finish Legend on drawings.
1. Graphic: As shown on drawings
- F. Trim: As indicated on Finish Legend on drawings.

2.3 THERMOPLASTIC-POLYOLEFIN WALL COVERING <Insert drawing designation>

- A. Product: Subject to compliance with performance requirements, provide product indicated on Drawings.

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- B. Description: Provide products complying with Wallcoverings Association's W-101; free of PVC, chlorine, plasticizers, formaldehyde, heavy metals, and halogenated fire retardants; with water-based inks and coatings; with antimicrobial additives; and in rolls from same production run.
 - 1. Type: [Type I, Light] [Type II, Medium] [Type III, Heavy] Duty.
- C. Total Weight: <Insert> ounces/SY.
- D. Width: 54 inches to 75 inches as required by graphic.
- E. Backing: [Woven] [Nonwoven] fabric.
 - 1. Fiber Content: [Polyester cellulose] <Insert requirements>.
- F. Repeat: As indicated on drawings.
- G. Stain-Resistant Coating: Manufacturers standard coating.
- H. Colors, Textures, and Patterns:
 - 1. Graphic: As shown on drawings

2.8 ACCESSORIES

- A. Adhesive: Mildew-resistant, nonstaining[, **strippable** adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.
 - 1. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
- B. Primer/Sealer: Mildew resistant, complying with **requirements in Section 099123 "Interior Painting"** and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.
- C. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended in writing by wall-covering manufacturer.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 098433 - SOUND-ABSORBING WALL UNITS

GUIDELINES

1. *Verify applicable fire testing based on panel type and CBC Chapter 8 criteria. Comply with Chapter 26 if foam cores are used. Panels are considered wall finish, not decoration. Verify selection complies with fire testing "in manner intended for use" per Chapter 8.*
2. *Consider seismic anchorage for panels, including cleat mounted systems.*
3. *Fabric selection and core type is typically indicated in a Finish Legend on the drawings. Coordinate selection with specified technical criteria, particularly acoustical.*
4. *Acoustical analysis is critical to define panel thickness, core type, and required wall percentage to achieve desired NRC values. Section wall panels based on criteria and specify accordingly.*
5. *Review and apply CBC 1207.2 for ANSI S12.60 – 2020 for enhanced acoustical performance. Consider application without room size scope limitation allowed by code.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:
 1. Sound-absorbing wall panels.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: **450** or less.
 2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.

2.2 SOUND-ABSORBING WALL UNITS <Insert drawing designation>

- A. Product: Subject to compliance with performance requirements, provide product indicated on Drawings.
- B. Sound-Absorbing Wall Panel: Manufacturer's standard panel construction consisting of facing material **[laminated to front face, edges, and back edge border of core] [stretched over front face of edge-framed core and bonded or attached to edges and back of frame]**.
 1. Panel Shape: **Flat**.
 2. Mounting: Back mounted with manufacturer's standard **[hook-and-loop strips] [magnetic devices] [metal clips or bar hangers]**, secured to substrate.
 3. Core: <Insert.>

- a. Core-Face Layer: Manufacturer's standard **impact-resistant, acoustically transparent, copolymer sheet.**
4. Edge Construction: Manufacturer's standard **chemically hardened core with no frame.**
5. Edge Profile: **[Chamfered (beveled)] [Eased (small radius)] [Mitered (beveled to a point)] [Radiused (bullnosed)] [Square] [Custom profile as indicated on Drawings].**
6. Corner Detail in Elevation: **[Square] [Round, radius as indicated on Drawings] [Custom as indicated on Drawings]** with continuous edge profile indicated.
7. Facing Material: **As indicated on Drawings.**
8. Acoustical Performance: Sound absorption **[NRC] [or] [SAA]** of **[0.50 to 0.90] [0.60 to 0.70] [0.65 to 0.75] [not less than 0.65]** <Insert range or single value> according to ASTM C 423 for **[Type A]** mounting according to ASTM E 795.
9. Nominal **[Core] [Overall Panel]** Thickness: **[3/4 inch] [1 inch] [1-1/2 inches] [2 inches] [As indicated on Drawings].**
10. Panel Width: **As indicated on Drawings.**
11. Panel Height: **As indicated on Drawings.**

2.3 MATERIALS

- A. Facing Material: Fabric from same dye lot; color and pattern **as indicated on Drawings and as specified.**
 1. Manufacturer: <Insert manufacturer's name>.
 2. Product Line/Pattern: <Insert product name or designation>.
 3. Pattern Repeat: <Insert requirement>.
 4. Style Number: <Insert number>.
 5. Color: <Insert name or number, or both>.
 6. Fiber Content: **[100]** <Insert number> percent **[woven polyester] [nonwoven polyester] [polyolefin] [acoustically transparent vinyl]** <Insert fiber requirement>.
 7. Width: **[54 inches] [66 inches]** <Insert dimension>.
 8. Source: <Insert fabric-vendor's name>.
 9. Applied Treatments: **[Stain resistance] [and] [flame retardant]** <Insert treatment>.
- B. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:

2.4 FABRICATION

- A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
- B. Edge Hardening: For **glass-fiber board** cores, chemically harden core edges and areas of core where mounting devices are attached.
- C. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.
- D. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.
 1. Square Corners: Tailor corners. **[Heat-seal vinyl fabric seams at corners.]**
 2. Radius and Other Non square Corners: Attach facing material so there are no seams or gathering of material.
 3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

E. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 099113 - EXTERIOR PAINTING

GUIDELINES

1. *Confirm all paint systems meet current SCAQMD regulations.*
2. *District has established specific colors for various elements. Review Design Standards.*
3. *District typically does not request attic stock. Confirm on project basis.*
4. *Verify all sheens listed in this Section with District. Provide semi-gloss sheen at metal finishes unless otherwise approved by District.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on **exterior** substrates as identified in schedule:

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Paint all exterior exposed surfaces throughout project.
 1. Paint all exposed surfaces whether or not colors are designated, except where the natural finish of the material is obviously intended or specifically indicated as a surface not to be painted.
 2. Where items or surfaces are not specifically indicated, paint them to match adjacent similar materials or areas.
 3. Specified surface preparation, priming, and paint coats are in addition to surface preparation and shop priming specified in other Sections.
 4. Compatibility: Examine shop-primed surfaces indicated as receiving paint, review for compatibility with paint systems included in this Section, the manufacturer's product data and other information indicated in those sections that specify the primers.
 - a. Provide finish coats compatible with the prime coats used, provide barrier coats over incompatible primer, or remove and re-prime.
 - b. Verify chemical and adhesive compatibility of all other components within the complete coating system.
 5. Unless otherwise indicated or noted, do not paint the following surfaces
 - a. Concrete
 - b. Roofing
 - c. Insulation and its facing.
 - d. Finish hardware, except those items specified with a USP finish.
 - e. Prefinished metal surfaces such as anodized aluminum, stainless steel, chromium plating, copper, bronze, brass and similar finished materials.
 - f. Walls or ceilings in concealed and inaccessible areas, such as furred areas.
 - g. Moving, mechanical or electrical parts of operating units, such as valve and damper operator linkages, sinkages, sensing devices, motor and fan shafts or similar parts.
 - h. Nameplates, code-required labels such as UL and FM, or other equipment identification, performance rating, name, or nomenclature plates.

- B. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed to view from public spaces. Does not apply to roof penthouse, transformers, generators, roof top mechanical, and similar elements.
 - a. Equipment, including panelboards and switch gear.
 - 1) Apply using roller or brush application – do not spray.
 - 2) Paint only those exposed panel elements visible when cover or door is closed. Do not paint interior of panel or device.
 - 3) Remove the panel cover fully before painting. Do not paint when attached and energized.
 - 4) After reattaching the cover, verify the door opens and latches completely and properly. Verify painting does not mechanically obstruct operation
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Sherwin-Williams Company.
 - 2. Dunn-Edwards Corporation.
 - 3. Vista Paint Corporation.
- B. Products: Subject to compliance with requirements, provide one of the products listed in "Exterior Painting Schedule" article below for the paint category indicated or an acceptable comparable product.
- C. Colors: As selected by Architect from manufacturer's full range.
 - 1. Provide District approved colors as defined in Design Standards.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

2.4 EXTERIOR PAINTING SCHEDULE

A. Concrete, Stucco, Cement Plaster and Masonry (Other than Concrete Masonry Units):

1. Flat Sheen:

a. Sherwin-Williams Company:

- 1) Primer: Loxon Concrete & Masonry Primer, LX2W50.
- 2) First and Second Coats: A-100 Exterior Latex Flat A6 Series.

b. Dunn-Edwards Corporation:

- 1) Primer: DE EFF Stop Select ESSL00 Primer.
- 2) First and Second Coats: DE Spartashield SSSL10 Flat Paint.

c. Vista Paint Corporation:

- 1) Primer: Uniprime II, 4700 Tilt-Up Primer.
- 2) First and Second Coats: Coverall 100% Acrylic Flat, 2200.

2. Semi-Gloss Sheen:

a. Sherwin-Williams Company:

- 1) Primer: Loxon Concrete & Masonry Primer, LX2W50.
- 2) First and Second Coats: A-100 Exterior Gloss Latex A8 Series.

b. Dunn-Edwards Corporation:

- 1) Primer: DE EFF Stop Select ESSL00.
- 2) First and Second Coats: DE Spartashield SSSL50 Semi-Gloss.

c. Vista Paint Corporation:

- 1) Primer: Uniprime II, 4700 Tilt-Up Primer.
- 2) First and Second Coats: Acriglo Acrylic Semi-Gloss, 7000.

B. Concrete Masonry Units:

1. Flat Sheen:

a. Sherwin-Williams Company:

- 1) Block Filler (New CMU): Prep Rite Blockfiller B25W25.
- 2) First and Second Coats: A-100 Exterior Latex Flat A6 Series.

b. Dunn-Edwards Corporation:

- 1) Block Filler (New CMU): Bloc-fil Select SSSL00 Smooth Block Filler.
- 2) First and Second Coats: DE Spartashield SSSL10 Flat Paint.

c. Vista Paint Corporation:

- 1) Block Filler (New CMU): Block Kote Block Filler, 040.
- 2) First and Second Coats: Coverall 100% Acrylic Flat, 2200.

2. Semi-Gloss Sheen:

a. Sherwin-Williams Company:

- 1) Block Filler (New CMU): Prep Rite Blockfiller B25W25.
- 2) First and Second Coats: A-100 Exterior Gloss Latex A8 Series.

- b. Dunn-Edwards Corporation:
 - 1) Block Filler (New CMU): Bloc-fil Select SBSL00 Smooth Block Filler.
 - 2) First and Second Coats: DE Spartashield SSSL50 Semi-Gloss.
 - c. Vista Paint Corporation:
 - 1) Block Filler (New CMU): Block Kote Block Filler, 040.
 - 2) First and Second Coats: Acriglo Acrylic Semi-Gloss, 7000
- C. Ferrous Metal:
- 1. Semi-Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unpainted Surfaces): Pro-Cryl Universal Primer, B66-1300 Series.
 - 2) First and Second Coats: Pro Industrial DTM Acrylic Coating S/G B66-1150 Series.
 - b. Dunn-Edwards Corporation:
 - 1) Primer (Unpainted Surfaces): DE Bloc-Rust Primer BRPR-00-1 (RED or WHITE).
 - 2) First and Second Coats: DE Spartashield SSSL50 Semi-Gloss.
 - c. Vista Paint Corporation:
 - 1) Primer (Unpainted Surfaces): Protec Metal Primer, 9600.
 - 2) First and Second Coats: Acriglo Acrylic Semi-Gloss, 7000
 - 2. Full Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unpainted Surfaces): Pro-Cryl Universal Primer, B66-1300Series.
 - 2) First and Second Coats: Pro Industrial DTM Acrylic Gloss, B66- 1050 Series.
 - b. Dunn-Edwards Corporation:
 - 1) Primer (Unpainted Surfaces): Enduraprime Acrylic Rust Preventive Primer ENPR00.
 - 2) First and Second Coats: DE W10 WB Syn-Lustro Enamel. ENDURA-COAT® Interior/Exterior Gloss Industrial Maintenance Coating (ENCT60)
 - c. Vista Paint Corporation:
 - 1) Primer (Unpainted Surfaces): Protec Metal Primer, 9600.
 - 2) First and Second Coats: Protec Gloss, 9900.
- D. Zinc-Coated (Galvanized) Metal:
- 1. Semi-Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer: Pro-Cryl Universal Primer, B66-1300 Series.
 - 2) First and Second Coats: Pro Industrial DTM Acrylic Coating Semi-Gloss B66-1150 Series.

- b. Dunn-Edwards Corporation:
 - 1) Primer: DE Ultra-Grip Primer. ULTRASHIELD® Galvanized Metal Primer (ULGM00).
 - 2) First and Second Coats: DE Spartashield SSSL50 Semi-Gloss.
 - c. Vista Paint Corporation:
 - 1) Primer: Metal Pro Primer, 4800.
 - 2) First and Second Coats: Protec Semi-Gloss, 9800.
2. Full Gloss Sheen:
- a. Sherwin-Williams Company:
 - 1) Primer: Pro-Cryl Universal Primer, B66-1300 Series.
 - 2) First and Second Coats: Pro Industrial DTM Acrylic Coating Gloss, B66-1050 Series.
 - b. Dunn-Edwards Corporation:
 - 1) Primer: DE Ultra Grip UGPR00 Primer. ULTRASHIELD® Galvanized Metal Primer (ULGM00).
 - 2) First and Second Coats: DEW10 WB Syn-Lustro Enamel. ENDURA-COAT® Interior/Exterior Gloss Industrial Maintenance Coating (ENCT60)
 - c. Vista Paint Corporation:
 - 1) Primer: Metal Pro Primer, 4800.
 - 2) First and Second Coats: Protec Gloss, 9900.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 099123 - INTERIOR PAINTING

GUIDELINES

1. *Confirm all paint systems meet current SCAQMD regulations.*
2. *District has established specific colors for various elements. Review Design Standards.*
3. *District typically does not request attic stock. Confirm on project basis.*
4. *Verify all sheens listed in this Section with District. Provide semi-gloss sheen at metal finishes unless otherwise approved by District.*
5. *Coordinate location and painting criteria for structural steel "protected zones" with SEOR as specified.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates as identified in schedule.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Paint all exterior exposed surfaces throughout project.
 1. Paint all exposed surfaces whether or not colors are designated, except where the natural finish of the material is obviously intended or specifically indicated as a surface not to be painted.
 - a. Unless otherwise indicated, paint exposed ductwork and supports.
 2. Where items or surfaces are not specifically indicated, paint to match adjacent similar materials or areas.
 3. Specified surface preparation, priming, and paint coats are in addition to surface preparation and shop priming specified in other Sections.
 4. Compatibility: Examine shop-primed surfaces indicated as receiving paint, review for compatibility with paint systems included in this Section the manufacturer's product data and other information indicated in those sections that specify the primers.
 - a. Provide finish coats compatible with the prime coats used, provide barrier coats over incompatible primer, or remove and re-prime.
 - b. Verify chemical and adhesive compatibility of all other components within the complete coating system.
 5. Unless otherwise indicated or noted, do not paint the following surfaces
 - a. Concrete
 - b. Insulation and its facing.
 - c. Finish hardware, except those items specified with a USP finish.
 - d. Prefinished metal surfaces such as anodized aluminum, stainless steel, chromium plating, copper, bronze, brass and similar finished materials.
 - e. Walls or ceilings in concealed and inaccessible areas, such as furred areas.
 - f. Moving, mechanical or electrical parts of operating units, such as valve and damper operator linkages, sinkages, sensing devices, motor and fan shafts or similar parts.
 - g. Nameplates, code-required labels such as UL and FM, or other equipment identification, performance rating, name, or nomenclature plates.

- B. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panel boards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or another paintable jacket material.
 2. Paint the following work where exposed to view from public spaces.
 - a. Equipment, including panelboards and switch gear.
 - 1) Apply using roller or brush application – do not spray.
 - 2) Paint only those exposed panel elements visible when cover or door is closed. Do not paint interior of panel or device.
 - 3) Remove the panel cover fully before painting. Do not paint when attached and energized.
 - 4) After reattaching the cover, verify the door opens and latches completely and properly. Verify painting does not mechanically obstruct operation
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Duct work and supports.
 - f. Metal conduit.
 - g. Plastic conduit.
 - h. Tanks that do not have factory-applied final finishes.
 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces with paint complying with following requirements as labeled by approved testing laboratory to:
 - a. Have flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with ASTM E 84.
 - b. Not flame, glow, smolder, or smoke when tested in accordance with ASTM C411 at rated temperatures not less than 250 degrees F.
- C. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- D. VOC Requirements:
1. Adhesives, sealants, primers, paints and coatings: Comply with SCAQMD VOC content and emission regulations.

- E. Coordination with Structural Steel Protected Zone: Identify protected zones as identified on structural drawings. Coordinate sequence and application of protected zone painting and signage specified in this section.
 - 1. Identification of Structural Steel Special Moment Frame and BRB Frame Connection Protected Zones:
 - a. Provide paint finish at all structural steel protected zones in contrasting colors on both sides of member. Apply paint immediately after application and final curing of fire-resistant coatings.
 - b. Apply paint in solid contrasting color or pattern as required by DSA.
 - c. Provide preprinted sign, permanently attached to fire resistant coating, characters one inch high, all capitals, with message: "PROTECTED ZONE – CONNECTIONS AND PENETRATIONS ARE PROHIBITED WITHIN THE PROTECTED ZONE. IT IS A CODE VIOLATION TO MAKE SUCH CONNECTIONS OR PENETRATIONS IN THIS REGION " or other DSA approved language. If permitted by DSA, message may stenciled on fire steel member or resistant coating with smooth surfaced finish.
- F. Colors: As indicated in Finish Schedule on Drawings.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Sherwin-Williams Company.
 - 2. Vista Paint Corporation.
 - 3. Dunn Edwards
- B. Products: Subject to compliance with requirements, provide one of the products listed in "Interior Paint Schedule" article below for the paint category indicated or an acceptable comparable product.

2.3 PAINT, GENERAL

- A. Material Compatibility:
 - 1. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Colors: As selected by Architect from manufacturer's full range.
 - 1. Provide District approved colors as defined in Design Standards.

2.4 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

2.5 INTERIOR PAINT SCHEDULE – PNT - # as indicated on Finish Legend.

A. Gypsum Board:

1. Flat Sheen:

a. Sherwin-Williams Company:

- 1) Primer (Unpainted Surfaces): ProMar 200 Zero VOC Interior Latex Primer, B28W2600.
- 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Flat, B30-2600 Series.

b. Vista Paint Corporation:

- 1) Primer (Unpainted Surfaces): V-Pro Primer, 5001.
- 2) First and Second Coats: V-Pro Flat, 5100.

c. Dunn Edwards:

- 1) Primer: Vinylastic Select Zero VOC Wall Sealer VNSL00.
- 2) First and Second Coats: Spartazero Zero VOC Flat Paint SWLL10.

2. Low-Luster, Satin or Eggshell Sheen:

a. Sherwin-Williams Company:

- 1) Primer (Unpainted Surfaces): ProMar 200 Zero VOC Interior Latex Primer, B28W2600.
- 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Eg-Shel, B20-2650 Series.

b. Vista Paint Corporation:

- 1) Primer (Unpainted Surfaces): V-Pro Primer, 5001.
- 2) First and Second Coats: V-Pro Eggshell, 5300.

c. Dunn Edwards:

- 1) Primer: Vinylastic Select Zero VOC Wall Sealer VNSL00.
- 2) First and Second Coats: Spartawall Zero VOC Eggshell SWLL30.

3. Semi-Gloss Sheen:

a. Sherwin-Williams Company:

- 1) Primer (Unpainted Surfaces): ProMar 200 Zero VOC Interior Latex Primer, B28W2600.
- 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex S/G, B31-2650 Series.

b. Vista Paint Corporation:

- 1) Primer (Unpainted Surfaces): V-Pro Primer, 5001.
- 2) First and Second Coats: V-Pro Semi-Gloss, 5400.

c. Dunn Edwards:

- 1) Primer: Vinylastic Select Zero VOC Wall Sealer VNSL00.
- 2) First and Second Coats: Spartazero Zero VOC Semi-Gloss SWLL50.

4. Full-Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unpainted Surfaces): ProMar 200 Zero VOC Interior Latex Primer, B28W2600.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Gloss, B11-2200 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unpainted Surfaces): V-Pro Primer, 5001.
 - 2) First and Second Coats: Acriglo Acrylic Semi-Gloss, 7700.
 - c. Dunn Edwards:
 - 1) Primer: Vinylastic Select Zero VOC Wall Sealer VNSL00.
 - 2) First and Second Coats: Spartashield 100% Acrylic Gloss SWLL60.
- B. Overhead Exposed Construction with Spray Applied Fireproofing: One coat flat dry fallout coating system to cover fireproofing, formulated for compatibility with all substrates by any paint manufacturer specified in this Section.
 1. Use 100 percent acrylic latex, flat finish, non-bridging flash-rust-resistance dryfall paint as approved by sprayed fire resistant material manufacturer that does not compromise fire rating or acoustical performance.
- C. Mechanical and Electrical Items: Use 3-coat system best suited to substrate, satin finish. Use heat-resistant materials where required.
- D. Ferrous Metal:
 1. Satin or Eggshell Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unfinished Surfaces): Pro-Cryl Universal Primer, B66-310 Series or Pro-Cryl Universal Primer, B66-1310 Series.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior latex Eg-Shel, B20-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unfinished Surfaces): Metal Pro Primer, 4800.
 - 2) First and Second Coats: V-Pro Eggshell, 5300.
 - c. Dunn Edwards:
 - 1) Primer: Enduraprime W/B Rust Preventive Primer ENPR00.
 - 2) First and Second Coats: Spartawall Zero VOC Eggshell Paint SWLL30.
 2. Semi-Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unfinished Surfaces): Pro-Cryl Universal Primer, B66-301 Series.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex S/G, B31-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unfinished Surfaces): Metal Pro Primer, 4800.
 - 2) First and Second Coat: V-Pro Semi-Gloss, 5400.

3. Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unfinished Surfaces): Pro-Cryl Universal Primer, B66-310 Series or Pro-Cryl Universal Primer, B66-1310 Series.
 - 2) First and Second Coats: ProMar 200 Latex Gloss, B11-2200 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unfinished Surfaces): Metal Pro Primer, 4800.
First and Second Coats: Acriglo Acrylic Gloss, 7700
 - c. Dunn Edwards:
 - 1) Primer: Enduraprime W/B Rust Preventive Primer ENPR00.
 - 2) First and Second Coats: Spartawall Zero VOC Semi-Gloss SWLL50.
- E. Zinc-Coated (Galvanized) Metal:
 1. Satin or Egg-Shell Sheen:
 - a. Sherwin-Williams:
 - 1) Primer (Unfinished Surfaces): ProCryl Universal Primer, B66-310 Series or ProCryl Universal Primer, B66-1310 Series.
 - 2) First and Second Coats: ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unfinished Surfaces): Metal Pro Primer, 4800.
 - 2) First and Second Coats: V-Pro Eggshell, 5300.
 - c. Dunn Edwards:
 - 1) Primer: Ultra-Grip Select Zero VOC Multi-Surface Primer UGPR00.
 - 2) First and Second Coats: Spartawall Zero VOC Eggshell Paint SWLL30.
 2. Semi-Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unfinished Surfaces): ProCryl Universal Primer, B66-310 Series or ProCryl Universal Primer, B66-1310 Series.
 - 2) First and Second Coats: ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unfinished Surfaces): Metal Pro Primer, 4800.
 - 2) First and Second Coats: V-Pro Semi-Gloss, 5400.
 - c. Dunn Edwards:
 - 1) Primer: Ultra-Grip Select Zero VOC Multi-Surface Primer UGPR00.
 - 2) First and Second Coats: Spartawall Zero VOC Semi-Gloss SWLL50.
 3. Full-Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unfinished Surfaces): ProCryl Universal Prier, B66-310 Series or ProCryl Universal Primer, B66-1310 Series.
 - 2) First and Second Coats: ProMar 200 Latex Gloss, B11-2200 Series.

- b. Vista Paint Corporation:
 - 1) Primer (Unfinished Surfaces): Metal Primer, 4800.
 - 2) First and Second Coats: Acriglo Acrylic Gloss, 7700.
- c. Dunn Edwards:
 - 1) Primer: Ultra-Grip Select Zero VOC Multi-Surface Primer UGPR00.
 - 2) First and Second Coats: Spartashield 100% Acrylic Gloss SWLL60.
- F. Overhead Exposed Construction (Deck, Joists, Steel): Two coats flat dry fallout coating system to cover formulated for compatibility with all substrate by any paint manufacturer specified in this Section. Use 100 percent acrylic, flash-rust-resistance dryfall.
 - 1. Sherwin-Williams Company: Pro Industrial Waterborne Acrylic Dryfall Flat, B42W00181.
 - 2. Vista Paint Corporation: DryFall Flat, DF12.
 - 3. Dunn Edwards: Aquafall Flat Dry Fall Paint AQUA10.
- G. Exposed PVC Piping:
 - 1. Sherwin-Williams Company:
 - a. Bond Coat: Extreme Bond Bonding Primer, B51W150.
 - b. First and Second Coats: ProMar 200 Zero VOC Latex Eg-Shel, B2600 Series.
 - 2. Vista Paint Corporation:
 - a. Bond Coat: Terminator Stain Blocking Primer/Sealer, 4200.
 - b. Top Coat: V-Pro Eggshell, 5300.
- H. Concrete and Masonry Other Than Concrete Masonry Units:
 - 1. Flat Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer: Loxon Concrete & Masonry Primer/Sealer, LX2W50.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Flat, B30-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unpainted Surfaces): Uniprime II, 4600.
 - 2) First and Second Coats: V-Pro Eggshell, 5300.
 - 2. Low-Luster, Satin, or Eggshell Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unpainted Surfaces): ProMar 200 Zero VOC Interior Latex Primer, B28W2600.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Eg-Shel, B20-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unpainted Surfaces): V-Pro Primer, 5001.
 - 2) First and Second Coats: V-Pro Eggshell, 5300.
 - c. Dunn Edwards:
 - 1) Primer: Ultra-Grip Select Zero VOC Multi-Surface Primer UGPR00.
 - 2) First and Second Coats: Spartazero Zero VOC Flat Paint SWLL10.

3. Semi-Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unpainted Surfaces): ProMar 200 Zero VOC Interior Latex Primer, B28W2600.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series.
 - b. Dunn Edwards:
 - 1) Primer: Ultra-Grip Select Zero VOC Multi-Surface Primer UGPR00.
 - 2) First and Second Coats: Spartawall Zero VOC Semi-Gloss Paint SWLL50.
 - c. Vista Paint Corporation:
 - 1) Primer (Unpainted Surfaces): Uniprime II, 4600.
 - 2) First and Second Coats: V-Pro Semi-Gloss, 5400.
- I. Concrete Masonry Units:
 1. Satin or Eggshell Sheen:
 - a. Sherwin-Williams Company:
 - 1) Block Filler (Unfinished Surface): PrepRite Latex Block Filler B25W25.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Flat, B30-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Block Filler (Flat): Smooth BLOCFIL Select Interior/Exterior Concrete Block Filler (SBSL00)
 - 2) First and Second Coats: ACRI-WALL Interior Eggshell Paint (ACWL30)
 - c. Dunn Edwards:
 - 1) Block Filler (Unpainted Surfaces): Smooth BlocFil Select Block Filler SBPR0.
 - 2) First and Second Coats: Spartawall Zero VOC Eggshell Paint SWLL30.
 2. Semi-Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Block Filler (Unpainted Surfaces): PrepRite Latex Block Filler B25W25.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Flat, Semigloss, B31-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unpainted Surfaces): Block Kote Block Filler, 040.
 - 2) First and Second Coats: V-Pro Semi-Gloss, 5400.
 - c. Dunn Edwards:
 - 1) Block Filler (Unfinished Surfaces): Smooth BlocFil Select Block Filler SBPR0.
 - 2) First and Second Coats: Spartawall Zero VOC Eggshell Paint SWLL30.

J. Plaster:

1. Satin, Low-Luster, or Eggshell Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unfinished Surfaces): Loxon Concrete & Masonry Primer, A24W8300.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Eg-Shel, B20-2650 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unpainted Surfaces): Uniprime II, 4000.
 - 2) First and Second Coats: V-Pro Eggshell, 5300.
 - c. Dunn Edwards:
 - 1) Primer: Ultra-Grip Select Zero VOC Multi-Surface Primer UGSL00.
 - 2) First and Second Coats: Spartazero Zero VOC Eggshell SWLL30.

K. Woodwork and Hardboard Painted:

1. Satin or Eggshell Sheen:
 - a. Sherwin-Williams Company:
 - 1) Primer (Unfinished Surfaces):Preprite ProBlock Primer, B51-600 Series.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex Eg-Shel, B20-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unpainted Surfaces): Uniprime, 4000.
 - 2) First and Second Coats: Acriglo Acrylic Eggshell, 7500.
 - c. Dunn Edwards:
 - 1) Primer: Ultra-Grip Select Zero VOC Multi-Surface Primer UGSL00.
 - 2) First and Second Coats: Spartawall Zero VOC Eggshell SWLL30.
2. Semi-Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Undercoat (Unfinished Surfaces):Preprite ProBlock Primer, B51-600 Series.
 - 2) First and Second Coats: ProMar 200 Zero VOC Interior Latex S/G, B31-2600 Series.
 - b. Vista Paint Corporation:
 - 1) Primer (Unfinished Surfaces): DECOPRIME Interior Cabinet, Door & Trim Primer (DCPR00)
 - 2) First and Second Coats: ACRI-WALL Interior Semi-Gloss Paint (ACWL50)
 - c. Dunn Edwards:
 - 1) Primer: Ultra-Grip Select Zero VOC Multi-Surface Primer UGSL00.
 - 2) First and Second Coats: Spartawall Zero VOC Semi-Gloss SWLL50.

3. Full Gloss Sheen:
 - a. Sherwin-Williams Company:
 - 1) Undercoat (Unfinished Surfaces): Prep Rite ProBlock Int/Ext Latex Primer, B51-620.
 - b. Vista Paint Corporation:
 - 1) Undercoat (Unpainted Surfaces): Uniprime II, 4000.
 - 2) First and Second Coats: Carefree Gloss, 8500.
 - c. Dunn Edwards:
 - 1) Primer: Ultra-Grip Select Zero VOC Multi-Surface Primer UGSL00.
 - 2) First and Second Coats: Spartashield 100% Acrylic Gloss SSSL60.

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 099600 - HIGH-PERFORMANCE COATINGS

GUIDELINES

1. Confirm all paint systems meet current SCAQMD regulations.
2. Verify use of high-performance exterior coatings with District. Use should be applied only to those conditions where maintenance access is limited, and the coating's increased durability and color stability can be justified. Roof equipment screen enclosure framing and elevated structural steel are examples. The District may elect to use systems specified in 099113.
3. Specified epoxy coatings over gypsum board are typically used in labs, kitchens, janitor closets for increased moisture resistance.
4. District has established specific colors for various elements. Review Design Standards.
5. District typically does not request attic stock. Confirm on project basis.
6. Verify all sheens listed in this Section with District. Provide semi-gloss sheen at metal finishes unless otherwise approved by District.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and application of high-performance coating systems on the following substrates:
 1. Exterior Substrates:
 - a. Exposed exterior structural steel elements designed as primed – shop primed with zinc-rich primer.
 - b. Exterior elements designated as galvanized and painted.
 2. Interior Substrates:
 - a. Gypsum board epoxy finish.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Paint all exposed surfaces as specified throughout project.
 1. Paint all exposed surfaces whether or not colors are designated.
 2. Where items or surfaces are not specifically indicated, paint them to match adjacent similar materials or areas.
 3. Specified surface preparation, priming, and paint coats are in addition to surface preparation and shop priming specified in other Sections
 4. Compatibility: Examine shop-primed surfaces indicated as receiving paint, review for compatibility with paint systems included in this Section, the manufacturer's product data and other information indicated in those sections that specify the primers.
 - a. Provide finish coats compatible with the prime coats used, provide barrier coats over incompatible primer, or remove and re-prime.
 - b. Verify chemical and adhesive compatibility of all other components within the complete coating system.
 5. Unless otherwise indicated or noted, do not paint the following surfaces
 - a. Walls or ceilings in concealed and inaccessible areas, such as furred areas.
 - b. Nameplates, code-required labels such as UL and FM, or other equipment identification, performance rating, name, or nomenclature plates.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Tnemec Company, Inc.
 - 2. Sherwin Williams
 - 3. Or equal
- B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to products listed in the schedule for the coating category indicated.

2.3 HIGH-PERFORMANCE COATINGS, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
- B. Low-Emitting Materials: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Colors: As selected by Architect from manufacturer's full range.
 - 1. Provide District approved colors as defined in Design Standards.

2.4 HIGH-PERFORMANCE COATING SCHEDULE

- A. Steel Substrates where indicated as coated per 099600:
 - 1. Exterior Polyurethane System – HPC-1:
 - a. Prime Coat at shop: Tnemec 94-H2O Hydro-Zinc 94 Primer at 2.5 to 3.5 mils DFT.
 - b. Spot Prime and Field Touch Up: Tnemec 94-H2O Hydro-Zinc 94 Primer at 2.5 to 3.5 mils DFT.
 - c. Intermediate Coat: Tnemec Epoxoline II L69 at 2.0 to 4.0 mils DFT.
 - d. Topcoat: Tnemec Series 1095 Endura-Shield (Semigloss) at 2.0 to 5.0 mils DFT.
- B. Galvanized-Metal Substrates where indicated as coated per 099600:
 - 1. Acrylic HDP System – HPC-2:
 - a. Spot Prime and Field Touch Up: Tnemec 94-H2O Hydro-Zinc 94 Primer at 2.5 to 3.5 mils DFT.
 - b. Intermediate Coat: Tnemec Series V115 UniBond DF at 2.0 to 4.0 mils DFT.
 - c. Topcoat: Tnemec Series 1029 Endurabond (Semigloss) at 2.0 to 3.0 mils DFT.
- C. Interior Gypsum Board Substrates -
 - 1. Epoxy-Modified Latex System:
 - a. Sherwin Williams:
 - 1) Prime Coat: Manufacturers recommended primer, 3.0 mils DFT.
 - 2) Intermediate and Finish coat – Satin Finish: Water Based Pro-Industrial Water Based Catalyzed Epoxy B73 Series, 3.5 – 4.0 mils DFT each coat.

PART 3 - EXECUTION – NOT USED

END OF SECTION

HIGH-PERFORMANCE COATINGS

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SECTION 099623 - GRAFFITI-RESISTANT COATINGS

GUIDELINES

1. Confirm all systems meet current SCAQMD regulations.
2. Both sacrificial and non-sacrificial systems are specified. Typically non-sacrificial systems have high gloss. Verify application with District.
3. Systems require graffiti removal compound.
4. District typically does not request attic stock. Confirm on project basis.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Provide **one of the following graffiti-resistant coatings** where indicated on Drawings:
 1. Aqueous silane anti-graffiti coating - Sacrificial.
 2. Cross-linking co-polymer anti-graffiti coating – Non-Sacrificial.

PART 2 - PRODUCTS

2.1 AQUEOUS SILANE ANTI-GRAFFITI COATING – SACRIFICIAL

- A. Basis-of-Design Product: Subject to compliance with requirements, provide
 1. Prosoco Sure Clean Weather Seal
 2. Or equal
- B. Description: Aqueous silane system designed to protect porous mineral building material surfaces from graffiti with very low VOC content, vapor permeable, and the following characteristics:
 1. Protects from graffiti.
 2. Repels water, oil and solvent-based paints on porous mineral building materials.
 3. Renders substrate hydro and oleophobic.

2.2 ANTI-GRAFFITI COATING – NON-SACRIFICIAL

- A. Basis-of-Design Product: Subject to compliance with requirements, provide VandlGuardTEN System by Rainguard International, Inc. **or comparable product**.
 1. Base Coat: VandlGuardTEN Non-Sacrificial Graffiti Coating.
 2. Finish Coat: VandlGuard Finish Coat Non-Sacrificial Graffiti Coating.
 3. Water Repellant: Micro-Seal Water Repellant.
 4. Graffiti Remover: Rainguard Vandl Clean Super Graffiti Remover.
- B. Description: Three-coat cross-linking co-polymer coating system that dries clear (non-yellowing) with low-luster sheen and consists of two coats of base coating and one finish coat.
- C. Warranty: Specified system shall provide 10-year warranty stipulating effective graffiti removal for not less than 10 years and warrant that treated surfaces can be effectively and repeatedly cleaned of graffiti without damage or loss of effectiveness of the graffiti resistant coating.

D. Properties and Characteristics:

1. Permeability: 100 percent permeable.
2. Solids Content by Volume: Approximately 40.0 percent.
3. Solids Content by Weight: Approximately 58.0 percent.
4. Odor: Similar to latex paint.
5. Application Temperature Range: 40 deg. to 100 deg. F.
6. Finish: Clear.
7. Volatile Organic Compound Content: Less than 20 g/L.
8. Flash Point: Non-Flammable.
9. Surface Dry Time: 1 to 2 Hours.
10. Full Chemical Cure: 72 to 96 Hrs at 75 deg. F.

PART 3 - EXECUTION - NOT USED

END OF SECTION 099623

SECTION 101100 - VISUAL DISPLAY UNITS

GUIDELINES

1. Coordinate anchorage provisions, including seismic.
2. Coordinate compliance with accessibility regulations, including projections.
3. Custom tackboard fabrication specified for specific classroom functions. Consider use of factory tackboards from same manufacturer as display units.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Visual display board assemblies, porcelain type.
 2. Visual display board assemblies, glass type
 3. Custom Tackboard assemblies.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and CBC Chapter 11B.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: [25] <Insert value> or less.
 2. Smoke-Developed Index: [50] [450] <Insert value> or less.

2.2 GLASS MARKERBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide specified system as manufactured by Clarus.
- B. Glass Markerboards: Fabricated of 6-mm tempered glass, back painted, with steel backing for use with magnets.
 1. Edge Treatment: Smooth polished edge with eased corners.
 2. Frame: Aluminum trim in profile indicated.
 3. Surface: As selected by Architect.
 4. Color: As indicated on Finish Legend.
- C. Mounting:
 1. Tru-Mount System
 2. Aluminum T fabrication between panels where shown.
- D. Marker Tray: Aluminum, attached with magnet.
- E. Size: As shown on drawings.
- F. Safety Glazing Requirements: Comply with the California Building Code, including Chapter 24, and ANSI Z97.1 and CPSC Title 16 Part 1201 (16 CFR 1201).
 1. Permanently mark all glazing with approved identification.

2. Safety film shall not be used to satisfy safety glazing requirements.

2.3 VISUAL DISPLAY BOARD ASSEMBLY

- 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. Claridge Products and Equipment, Inc. or equal
- B. Series: Series 8, Type A, Factory Fabricated.
- C. Characteristics - Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with low-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.
 1. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard three-coat process.
 2. Face Sheet Thickness: 0.021 inch () uncoated base metal thickness.
 3. Manufacturer's Standard Core: MDF with no added urea formaldehyde, CARB certified, minimum 7/16 inch thick, with manufacturer's standard moisture-barrier backing.
 4. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.
 5. Color/gloss: White, matte gloss.
 6. Special-Purpose Graphics: Fuse or paint music staff lines graphic onto surface of porcelain-enamel visual display unit, in locations indicated.
- D. Characteristics - Aluminum Frames and Trim: Fabricated from not less than 0.062-inch-thick, extruded aluminum; slim size and standard shape.
 1. Field-Applied Trim: Manufacturer's standard, snap-on trim with no visible screws or exposed joints.
 2. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
 3. Chalk tray: Magnetic, Extruded aluminum with ribbed section and smoothly curved exposed ends, 12-inch length, maximum 4-inch projection.
 4. Display Rail: Manufacturer's standard, extruded-aluminum display rail.
 - a. Size: 1 inch high by length indicated on Drawings.
 - b. End Stops: Aluminum.
 - c. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches of display rail or fraction thereof.
 - d. Display Rail Insert: Manufacturers tackable surface, color as selected by Architect.
- E. Aluminum Finish:
 1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.4 CUSTOM TACKBOARD ASSEMBLY

- 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. Forbo.
- B. Series: Aluminum framed.
- C. Characteristics - Tackboard:
 1. Tackable Surface: Forbo Bulletin Board.
 2. Width: [48][72] inches.
 3. Thickness: 1/4 inch thick, with manufacturer's standard moisture-barrier backing.

VISUAL DISPLAY UNITS

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4. Laminating Adhesive: Manufacturer's standard moisture-resistant type.
 5. Fire Resistance: Class B per ASTM E84.
- D. Color: As selected by Architect from complete color line.
- E. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum, shape as indicated on drawings.
1. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
- F. Aluminum Finish:
1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 101416 - PLAQUES

GUIDELINES

1. *Coordinate plaque with Wayfinding criteria in the Design Guide.*
2. *Comply with applicable accessibility requirements.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Metal plaques.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and CBC Chapter 11B.

2.2 METAL PLAQUES

- A. Cast Plaque: Cast-metal plaque with background texture, border, and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 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. A.R.K. Ramos.
 - b. Gemini Incorporated.
 - c. Matthews International Corporation; Bronze Division.
 - d. Metal Arts.
 2. Plaque Material: Cast bronze.
 3. Plaque Thickness: 0.50 inch.
 4. Finishes:
 - a. Integral Metal Finish: As selected by Architect from full range of industry finishes.
 - b. Overcoat: Manufacturer's standard baked-on clear coating.
 5. Background Texture and border: As selected by Architect from manufacturer's full range.
 6. Mounting: As indicated on Drawings.
 7. Accessibility compliance:
 - a. Comply with CBC Chapter 11B tactile and braille message criteria, mounting reach range and projection requirements.
 8. Design and Message:
 - a. Text message and Typeface as indicated.
 - b. Message, size, and design as shown on drawings.
 - c. Include District logo as indicated.

2.3 MATERIALS

- A. Bronze Castings: ASTM B584, alloy recommended by manufacturer and finisher for finish indicated.

PLAQUES

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2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of plaques, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. For exterior exposure, furnish nonferrous metal devices unless otherwise indicated.
 - 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.

PART 3 - EXECUTION – NOT USED

END OF SECTION 101416

SECTION 101423 – SIGNAGE

GUIDELINES

1. *Provide complete design submittals conforming to Wayfinding criteria in Design Guide.*
2. *Coordinate all messaging with applicable accessibility code requirements.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes requirements for the following types of signs:
 1. Permanent room or space identification signage, interior and exterior.
 2. Directional and Informational Signage, interior and exterior.
 3. Site Directional and Informational Signage, exterior.
 4. Fire Code / Life Safety Signage.
 5. Exterior Building Identification Signage and Building Address Numerals.
 6. Exterior Campus Monument Signage.
- B. This section does not apply to signage specified in other sections related to operational or process requirements, such as electrical panel arc-fault signage, FDC signage, refrigerant cautions, etc.
- C. This section does not apply to variable messaging signage including those required by code, electronic display boards, room schedulers, etc.

1.2 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Signs and supporting elements will withstand the effects of gravity and other loads within limits and under conditions indicated.
- B. Accessibility Standard and Requirements: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and applicable CBC and CFC requirements.
- C. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.
- 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.

2.2 MATERIALS

- A. Metals:
 1. Aluminum:
 - a. Aluminum Castings: ASTM B 26/B 26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated; ASTM B 26 or B 108, alloy 214 for natural anodized finish, and alloy 43 for color anodized or baked enamel finish.

- b. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32. Sizes and minimum gauges as shown and as required to fulfill performance requirements. Suitable alloy and temper for forming and fabrication requirements with adequate temper and structural characteristics and suitable for finishing as specified.
 - c. Aluminum Extrusions: ASTM B 221/ASTM B 221M, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated. Shapes and thickness as shown and as required to fulfill requirements, unless otherwise shown. Suitable alloy and temper for extruding with adequate structural characteristics and suitable for finishing as specified.
2. Steel:
- a. Steel Materials:
 - 1) Metallic-Coated Steel Sheet: ASTM A 653/A 653M, coating recommended by Fabricator for intended purpose, either commercial or forming steel.
 - 2) Weathering Steel: ASTM A 606-4 hot and cold rolled steel sheet, strip and coil.
 - 3) Structural Steel Shapes and Plates: Grade as selected by Fabricator.
 - 4) Hot Rolled Steel Bars: Grade as selected by Fabricator.
 - 5) Steel Sheet: Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, Type B exposed.
 - 6) Steel Members Fabricated from Plate or Bar Stock: ASTM A 529/A 529M or ASTM A 572/A 572M, 42,000-psi (290-MPa) minimum yield strength.
 - 7) Steel Plate for Cold Forming: ASTM A 283, Grade C.
 - 8) Steel Pipe: ASTM A 53, Type E, F or S at fabricator's option, Grade A, black finished unless shown as galvanized, standard weight (Schedule 40) unless otherwise shown or specified.
 - 9) Hot-Formed Rectangular Steel Tubing: ASTM A butt-welded, cold finished and stress relieved.
 - 10) Galvanized Steel Sheet: ASTM A 256, commercial quality Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial or forming steel.
 - 11) Steel Sheet: Electrolytic zinc-coated, ASTM A 591/A 591M, with steel sheet substrate complying with ASTM A 1008/A 1008M, commercial steel, exposed.
 - 12) Steel Sheet for Cold Forming: ASTM A 569, hot-rolled sheet steel of commercial quality, pickled and oiled, free of defects which would impair the work.
 - 13) For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.
 - b. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, stretcher-leveled standard of flatness.

B. Plastics:

- 1. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing). Provide acrylic plastics equivalent to "Plexiglass" manufactured by Rohm and Haas Company, in sizes as shown. Provide colors as shown, or as selected.
 - a. Acceptable Products and Manufacturers:
 - 1) 3Form, Chroma, finish as selected by Designer.

- 2) Lumicor, Luminous, finish as selected by Designer.
 - 3) Luxface, Luxtone, finish as selected by Designer.
 - 4) Altuglas, Plexiglas.
 - 5) Acrylite, Evonik Cyro.
 - 6) Lucite, Lucite International.
 2. Polycarbonate Sheet: ASTM C 1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides. Provide in sizes and thickness as shown on drawings, manufactured by extrusion process, coated on both surfaces with abrasion-resistant coating:
 - a. Impact Resistance: 16 ft-lbf/in. (854 J/m) per ASTM D 256, Method A.
 - b. Tensile Strength: 9000 lbf/sq. in. (62 MPa) per ASTM D 638.
 - c. Flexural Modulus of Elasticity: 340,000 lbf/sq. in. (2345 MPa) per ASTM D 790.
 - d. Heat Deflection: 265 deg F (129 deg C) at 264 lbf/sq. in. (1.82 MPa) per ASTM D 648.
 - e. Abrasion Resistance: 1.5 percent maximum haze increase for 100 revolutions of a Taber abraser with a load of 500 g per ASTM D 1044.
 - f. Ultraviolet (UV) Resistant: Five year written warranty against breakage, yellowing and loss of light transmission.
 - g. Acceptable Products and Manufacturers:
 - 1) Cyro Industries, Cyrolon ZX.
 - 2) General Electric Company, Lexan.
 - 3) Lumicor Lumishield EX
 3. PVC Sheet: Manufacturer's standard, UV-light stable, PVC plastic.
 4. Plastic-Laminate Sheet: in colors and patterns shown, or as selected.
 - a. Provide one of the following:
 - 1) Nevamar: Exxon Chemical Co. USA.
 - 2) Wilson Art: Ralph Wilson Plastics Co.
 - 3) Formica Corporation: Divisions of Cyanamid Corporation.
 5. For panel signs, a minimum of ¼" sheet thickness shall be used, unless otherwise indicated.
 6. For direct digital printing on plastic sheet, the appropriate material and surface finish shall be used to promote permanent adherence of digital printing. A primer or printing promoter shall be used as recommended by manufacturer to ensure permanent adherence.
 - C. Vinyl Film: UV-resistant vinyl film with pressure-sensitive, permanent adhesive; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.
 - D. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.
- ### 2.3 LETTERS, NUMBERS, SYMBOLS, AND ICONS
- A. Graphics must carry lettering and symbols shown on the drawings for locations indicated on the drawings or as scheduled.
 - B. Provide camera ready art required to fabricate lettering and symbols.
 - C. Capital height of letter size and symbols must be as indicated on the drawings.
 - D. Unless otherwise noted, letter spacing must be optical spacing 20/1000em. Spacing between words must equal the horizontal dimension of a lower-case "m" for the size of the copy being used.

- E. Dimensional letters and/or incised letter forms must be laser or water jet cut.
- F. Typefaces:
 - 1. Typefaces used on the project are located in the construction documents under the Typography page.
 - 2. NFPA 170 publication "Standard for Fire Safety Symbols" must be referenced for fire safety symbols and required colors.
 - 3. NFPA 170 must be referenced for specific sign messages required.
 - 4. Fabricator must confirm and coordinate NFPA 170 requirements with Owner.

2.4 COLOR AND CLEAR COATINGS

- A. Coatings must be prepared as designated by manufacturers latest literature for surface preparation and application but in no case less than one applicable primer coat and two final full coats. Finished surfaces must be uniform.
- B. Finish in colors shown or selected.
- C. Strictly observe manufacturer's recommendations regarding application and mixing.
- D. Apply at the rate recommended by the manufacturer to achieve 100 percent coverage.
- E. Overall appearance must match specified color and pattern of sample. Pattern and sheen must be uniform. If primer is visible through paint when inspected, paint coverage will be considered incomplete and disapproved by the Owner or Architect/Designer. Should the Owner or Architect/Designer disapprove of the applied coating, the Contractor/Installer must bear all costs to complete paint finish.
- F. Color must be colorfast and non-fading when exposed to water, weather, and environmental variations.
- G. Polyurethane Enamel: Provide an aliphatic polyurethane enamel with ultra-violet inhibitors, light fast, weather, abrasions and wear resistant. Provide one of the following:
 - 1. Chemglaze; Hughson Chemical Division, Lord Corporation.
 - 2. Imron; DuPont de Nemours & Co.
 - 3. VOC MAP; Matthews Paint.
- H. Translucent Sign Coating: Grip-Flex by Wyandote Paint Products Co.
- I. Automotive Paint System: Grip Gard by Akzo Wyandotte or approved equal. Apply paint system strictly observing the manufacturer's recommendations regarding application technique using internal mix conventional spray equipment.
- J. Acrylic Polyurethane Enamels: Matthews Paint Company or equal.

2.5 SILK SCREEN INKS

- A. Screen printing specified must be executed from photo screens prepared from reproductions of the copy specified. Contractor/Installer must submit full size showings of foundry to be used. No hand-cut screens will be accepted.
- B. Screen printing must be executed in such a manner that edges and corners of finished letter forms and graphic devices are true and clean. Letterforms with rounded positive or negative corners, edge build-up or bleeding, etc. will not be accepted.
- C. Inks, paints and lacquers required for silk-screened or imprinted surfaces or other specified surfaces, must be a type made for the surface material on which it is to be applied and recommended by the manufacturer of the ink, paint, or substrate.

- D. Exact identification of ink and paint must be noted on the shop drawings, together with data describing the method of application and drying if other than air dried.
- E. Silk-screen inks must be made by a manufacturer with experience in production and consistency of such inks for the purposes and surfaces involved.
- F. No paint, ink or lacquer that will fade, discolor or delaminate as a result of proximity to UV light source or heat therefrom must be used.
- G. Inks, paints and lacquers must be evenly applied and without pinholes, scratches, orange peeling, application marks, etc. Rear-illuminated panels containing the above or other defects which cause light leaks in surface areas specified to be covered will not be accepted.
- H. Workmanship with finishes and formations of letters or graphics must conform to the standards of the trade and must be acceptable to the Architect/Designer and Owner.
- I. Prime coats or other surface pre-treatment, where recommended by the manufacturer for inks, paints or lacquers, must be included in the work and noted on the shop drawings, as part of the finished surface work at no extra cost to the Owner.
- J. Provide silk-screen inks in colors and sheen as specified, manufactured by one of the following or approved equal:
 - 1. Naz-Dar Company.
 - 2. Wornow Products Department, Dexter Corp.
 - 3. Colonial Printing Ink Co.

2.6 VINYL LETTERFORMS AND GRAPHICS

- A. Includes: Basic materials and fabrication methods for markings for cut out designs. No deviation from this specification is permissible without the written approval.
- B. Marking manufacturer must certify markings conform to this specification and will be replaced or repaired without cost if they fail to meet the requirements.
- C. Graphics must be weather-resistant and not affected by oil, water, salt spray or alcohol.
- D. Cut edges (i.e. laser, kiss cut, guillotined, etc.) must be smooth and free of ragged areas.
- E. Color, copy and logotype rendition must be approved prior to production.
- F. Where specifically noted, provide reverse cut copy for application to glass. All other applications must be "correct reading" on exterior of glass.
- G. Size, colors and shape of markings to be fabricated in accordance with manufacturer's product specifications for each item.
- H. Markings must be in accordance with the instruction bulletin published by the manufacturer.
- I. Finished emblems must be pre-masked.
- J. Typical: Pressure sensitive cut vinyl, pre-spaced and pre-aligned on transfer paper.
- K. Marking Film:
 - 1. Material: calendered vinyl (polymeric).
 - 2. Surface finish: glossy
 - 3. Thickness (film): 75 µm (0.075 mm)
 - 4. Adhesive type: solvent acrylic; pressure-sensitive
 - 5. Adhesive appearance: clear
 - 6. Liner: as recommended by the manufacturer for each application.
 - 7. Adhesion: 14 N/25 mm, FTM 1: 180° peel, substrate: glass; cond: 24 h 23°C/50%RH
 - 8. Application method: wet or dry

9. Applied shrinkage: less than 0.4 mm, FTM 14
10. Application temperature: minimum (air and substrate)
11. Service temperature: -40°C to +80°C

L. Applied Vinyl:

1. Die-cut characters from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure-sensitive adhesive backing, suitable for exterior applications.

2.7 DIGITALLY PRINTED GRAPHICS

A. Graphics Specifications Package for output methods and materials; for example, certain graphics may utilize techniques unique to the graphic type. Image materials and techniques include but are not limited to:

1. Silkscreen Inks.
2. Transparent films and other products.
3. Color lambda prints with protective polycarbonate overlamine or acrylic.
4. Acrylic letterforms as specified in the construction drawings.
5. Dimensional Graphics.
6. Hand painted area graphics and theming.
7. Murals, 3M ScotchPrint, Korographics Vinyl Wall Coverings.
8. Digital high-pressure laminate (Fossil Industries recommended).
9. Lightjet, Duratrans, Duraclear.

B. Surface Materials:

1. Conform to applicable codes for flame spread/smoke rating for surfaces in accordance with ASTM E84.
2. Substrates and housings include but are not limited to:
 - a. Painted metal.
 - b. Specified woods.
 - c. Satin Aluminum: 220# Random Orbital (DA) Finish.
 - d. Acrylic: 1/8-inch min. thickness unless otherwise noted.
 - e. Painted Medium-density fiberboard (MDF): made without formaldehyde and complying with ANSI A208.2. 1/2" thickness unless otherwise noted.
 - f. Metal and Glass and Acrylic Panels.
 - g. Applications to substrates provided and installed by others, see drawings (architectural wall/glass).
 - h. Existing gypsum board walls and banded plywood.
 - i. Graphic edges trimmed flush per graphic specifications.
3. No substitutions of materials will be permitted unless their properties are equal to, or better than, those produced by the 3M Company.

2.8 VINYL SHEET GRAPHICS AND SUBSTRATE

- A. Provide graphic marking materials (vinyl sheet, films, toners, and substrate materials) equivalent to Scotchprint and Panaflex manufactured by the 3M Company.
- B. No substitutions of materials will be permitted unless their properties are equal to, or better than, those produced by the 3M Company.
- C. Markings must be manufactured using materials and procedures described in the manufacturer's latest Product and Instruction Bulletins.
- D. Surface preparation and application of markings must use the materials, methods and tools described in the manufacturer's latest Product and Instruction Bulletins.

- E. Technical questions relating to the 3M products should be directed to 3M Commercial Graphics Technical Service.

2.9 ADHESIVES AND SEALANTS

- A. Contractor shall use adhesives and sealants appropriate for permanent bonding of substrates being adhered.
- B. Contractor to use adhesives for signs installed on existing walls and surfaces appropriate for permanent adherence to the existing condition. Surface materials and finishes may vary across project conditions and may require various adhesives.
- C. Foam Tape: 1.6mm thick double faced, white pressure sensitive urethane foam adhesive tape, one of the following:
 - 1. No. 4016; 3M Co.
 - 2. No. ST1132 Spectape; Spectape of Texas.
 - 3. No. AL4432YEAom9576, 3M Co.
- D. Film Tape Adhesive: 0.1mm thick, double-faced pressure sensitive tape, one of the following:
 - 1. No.415;3M Co.
 - 2. Macbank No. SB 1786 or No. 0530 - IS 0303 - KA1100; Morgan Adhesive Co.
 - 3. 3M VHB tape
- E. Epoxy: Two component thermosetting epoxy adhesive with 100percent solids content, one of the following:
 - 1. NP-428; Miracle Adhesives Corporation.
 - 2. Chemlok 304; Hughson Chemical Division of Lord Corporation.
- F. Silicone: FS TT-S-001543, Class A.
 - 1. Silicone Sealant 1200; General Electric Co.
 - 2. 781 Building Sealant, Dow Corning Corporation.

2.10 CODE REQUIREMENTS

- A. Braille:
 - 1. Where noted on Drawings or other Contract Documents, specific signs will require tactile characters, raised-line symbols, and Grade 2 Braille. Braille to be rounded beads chemically fused into an engraved bed, thermoformed, photopolymer, or 3D direct printed to substrate and adhered permanently to sign face.
 - 2. All Braille to adhere to sizing and spacing guidelines set forth per CBC 11B-703.3.
 - 3. All Braille translations shall be Grade 2.
 - 4. Dots shall have a domed or rounded shape and shall comply with guidelines set forth per CBC 11B-703.3.
 - 5. Sign fabricator is responsible for Braille translations and for proofreading of output Braille before installation of signs. All Braille translations shall be shown correctly as intended to be produced in Shop Drawing layouts provided by Fabricator.
 - 6. Braille translations to be in upper and lower case. The indication of an uppercase letter or letters shall only be used before the first word of sentences, proper nouns and names, individual letters of the alphabet, initials, and acronyms.
- B. Tactile Letters, Symbols and Pictograms:
 - 1. Items required to be tactile shall be raised 0.8mm (1/32 inch) from the plaque surface and thermoformed, photopolymer, or 3D direct printed to substrate and adhered permanently to sign face.

2. Letters to be set in all upper case and at least 16mm (5/8 inch) high based on the uppercase "I" and shall be accompanied by Grade 2 Braille.
 3. Letters shall be sans serif and non-decorative.
 4. Letters, Symbols and Pictograms shall contrast with their backgrounds, either light on dark background, or dark on light background.
 5. Character and line spacing shall be as indicated on Drawings. Where no spacing is indicated, adhere to guidelines set forth per CBC 11B-703.2.
 6. All tactile elements to be adhered permanently to prevent forms from scratching, cracking, and delaminating. Provide protective clearcoat over tactile elements to minimize damage, in a non-glare finish.
 7. Tactile symbols, where specified, to be accompanied by the equivalent text descriptions placed directly below the symbol. Tactile symbols to be on a field clear of other elements that is at least 152mm (6 inches) in height.
- C. Visual Letters, Symbols and Pictograms:
1. Visual letters, symbols and pictograms shall be screen printed or otherwise direct printed to substrate, unless otherwise noted, and adhered permanently to sign face. Provide protective clearcoat over tactile elements to minimize damage, in a non-glare finish.
 2. Letters to be set in upper case and lower case, and at least 16mm (5/8 inch) high based on the uppercase "I".
 3. Letters shall be sans serif and non-decorative.
 4. Letters, Symbols and Pictograms shall contrast with their backgrounds, either light on dark background, or dark on light background.
 5. Character and line spacing shall be as indicated on Drawings. Where no spacing is indicated, adhere to guidelines set forth per CBC 11B-703.5.
 6. Visual symbols to be on a field clear of other elements that is at least 152mm (6 inches) in height.
- D. Mounting Height:
1. Signage containing tactile lettering and Braille shall be located within 48" minimum as measured to the baseline of the lowest Braille cells and 60" maximum to the baseline of the highest line of tactile characters above the finish floor or ground surface.
 2. Signage containing visual lettering only shall be located 40" minimum as measured to the baseline of the lowest line of visual letters.
 3. All other signage shall be mounted 60" above the finish floor or ground surface as measured to the center of the sign, unless otherwise indicated.
- E. Mounting location: A tactile sign shall be located on the approach side, as one enters or exits a room or space, and shall be reached within the required clear floor space as follows:
1. A clear floor space of 18 inches x 18 inches minimum, centered on the tactile characters, shall be provided beyond the arc of any door swings between the closed position and 45-degree open position.
 2. On the wall at the latch side of a single door.
 3. On the inactive leaf of a double door with one active leaf.
 4. On the wall at the right side of a double door with two active leaves.
 5. On the nearest adjacent wall where there is no wall space at the latch side of a single door or no space at the right side of a double door with two active leaves.
- 2.11 ACCESSORIES
- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
1. Use concealed fasteners and anchors unless indicated to be exposed.

2. For exterior exposure, furnish stainless steel or hot-dip galvanized unless otherwise indicated.
 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened sign unless otherwise indicated.
 - b. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant Allen-head slots unless otherwise indicated.
 4. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
 - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
 - c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.
 5. Inserts: Furnish inserts to be set by other installers into concrete or masonry work.
- B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on requirements as appropriate for the substrate.
1. Uses: Securing signs with imposed loads to structure.
 2. Type: Torque-controlled, expansion anchor or adhesive anchor.
 3. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
- C. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Adhesive: As recommended by sign manufacturer.
1. Adhesives shall have a VOC content of 70 g/L or less.
 2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape with adhesive on both sides.
- F. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.
- G. Magnetic Tape: Manufacturer's standard magnetic tape with adhesive on one side.
- H. Foam Tape: 1.6mm thick double faced, white pressure sensitive urethane foam adhesive tape.
- I. Film Tape Adhesive: 0.1mm thick, double-faced pressure sensitive tape.
- J. Epoxy: Two component thermosetting epoxy adhesive with 100% solids content.
- K. Silicone: FS TT-S-001543, Class A.
- L. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

M. Anchoring Devices:

1. Channels, plates, angles, bolts, dowels, and other anchoring devices must be of the types and sizes shown on shop drawings. Anchoring devices must be engineered and provided by fabricator.
2. Cut or drill holes for bolts, dowels, and other anchoring devices indicated on shop drawings.
3. Furnish inserts and anchoring devices which must be set in concrete or built into other materials for installation of this work. Provide settings drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delays.
4. All graphic components must be anchored as shown on the shop drawings. Anchor graphic components securely in correct vertical and horizontal alignment.
5. Provide nonferrous-metal or hot-dip galvanized anchors and inserts unless otherwise indicated. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors.

2.12 PERMANENT ROOM IDENTIFICATION SIGNAGE

A. Materials: Design and materials as indicated in drawings.

B. Sign Message:

1. Wall Mounted Room Identification: Unless otherwise indicated, provide tactile signs at rooms as shown on drawings:
 - a. Permanent Room Signs: Room number and name as indicated on floorplans.
 - b. Toilet Room Signage: Designated gender symbol as indicated, with symbol of accessibility pictogram as required.
 - c. All-Gender Toilet Room Signage: All-Gender symbol as indicated, with symbol of accessibility pictogram as required.
 - d. Accessible Entrances: International Symbol of Accessibility as required.
2. Means of Egress Signage: Provide tactile signs at all means of egress components as indicated
 - a. Wall Mounted Exit Identification: Provide signs at all door locations with exit signs as required by CBC Section 1013.1 indicating the path of exit travel within the means of egress system as required by 1013.4.
 - 1) Message at all grade-level exits: "EXIT".
 - 2) Message at all path of egress conditions: "EXIT ROUTE".
 - b. Stair exit door locations with exit signs required by CBC Section 1013.4.
 - 1) Message: "EXIT STAIR [DOWN] [UP]".
 - c. Delayed Egress Locks:
 - 1) Provide signs at all door locations with delayed access locking as required by CBC Section 1010.1.9.
 - 2) Message shall include directions on operation and alarm.
 - d. Stair vestibule Identification:
 - 1) Provide signs at inside of stair at each door landing as required by CBC Section 1023.9 indicating the floor. At exit level provide star of life adjacent to and same size as floor designation.
 - e. Area of Refuge and Exterior Areas of Rescue Assistance:
 - 1) Provide signs designating Area of Refuge or Exterior Area of Rescue Assistance as required by CBC 1009.9.
 - 2) Provide International Symbol of Accessibility pictogram.
 - f. Elevator Lobby Two Way Communication:
 - 1) In elevator lobby, provide signs on instructions on the use of the area under emergency conditions, including use of two-way communication as required by CBC 1009.8.2 and 1009.11.

2.13 INTERIOR DIRECTIONAL AND INFORMATIONAL SIGNAGE

- A. Materials: Design and materials as indicated in drawings.
- B. Sign Message:
 - 1. Provide signage with message as indicated in drawings and as specified in Signage Message Schedule.
 - 2. Accessible Entrances: Provide sign with ISA at each entrance.
 - a. Provide sign with ISA at each building entrance.
 - b. Where a building entrance is not accessible, provide sign providing direction to nearest accessible element. Locate at inaccessible building entrances without accessible means of egress.
 - c. Provide sign with International Symbol of Accessibility and directional arrow as required to indicate accessible route to accessible entrance.
 - 3. Toilet room door sign: Provide door mounted signs, separate from room identification signage, complying with 12-inch triangle/circle size and edge requirements per CBC Chapter 11B – 703.7.2.6. Do not put symbols or tactile and braille message on sign.
 - 4. Assistive Listening Device Signage: Provide signs indicating availability of assistive listening devices in compliance with CBC 11B – 703.7.2.4. In addition, provide message on sign stating “Contact Facility staff to make arrangements for listening device” per CBC 11B- 216.10.
 - 5. Path of Travel Directional Signage:
 - a. Where a building element, such as a toilet, drinking fountain, dressing, fitting or locker room, exits or elevator are not accessible, provide sign at the inaccessible element providing direction to nearest accessible element.
 - b. Provide sign with International Symbol of Accessibility and directional arrow as required to indicate accessible route to accessible element.
 - c. Mounting: wall.
 - 6. Diaper Changing Station: Provide signs indicating availability of diaper changing station in accordance with California Statute.
 - 7. TTY Signage: Provide signs identified by the International Symbol of TTY as required by CBC11B-703.7.2.2:
 - 8. Telephones: Where public telephones are provided, including intercom and courtesy phones, provide signs as required by CBC11B-703.7.2.3.
 - 9. Wheelchair Lift Signage: Provide signs defining use of wheelchair lift as shown on drawings and in compliance with CBC Chapter 11B – 4.10.8.
 - 10. Live Load: Provide signage on floor or area where design live floor loads exceed 50 PSF per CBC 106.1
 - 11. No smoking: Provide no smoking signs as required by CFC 310.3

2.14 FIRE CODE INFORMATIONAL AND DIRECTIONAL SIGNAGE

- A. Materials: Design and materials as indicated in drawings.
- B. Sign Message:
 - 1. Occupant Limit Sign:
 - a. Provide sign with occupant limit number based on occupant load s required by CBC 1004.3 and as shown on approved drawings.
Mounting: Wall.
 - 2. Stair Identification Sign:
 - a. Provide sign with Stair Number, roof access, and other requirements as required by CBC 1023.9 and Fire Marshal.
 - b. Mounting: Wall.

3. Elevator and Stair Signage:
 - a. Provide sign as required by CBC 3008.2 with message: "In case of emergency, use stairs not elevator".
 - b. Mounting: Wall.
4. Elevator Evacuation Signage:
 - a. Provide sign as required by IBC 30028.2 and 30028.3 with custom graphic illustrating path to exit stairs.
 - b. Mounting: Wall.
5. Fire Extinguisher Identification Sign:
 - a. Provide sign with "Fire Extinguisher" to identify fire extinguisher location.
 - b. Mounting: Wall, perpendicular.
6. Main Entrance Door Locking:
 - a. Provide signs at main entrance door as required by CBC 1010.1.
 - b. Message shall "THIS DOOR TO REMAIN UNLOCKED WHEN THIS SPACE IS OCCUPIED".
7. Fire Door Signage:
 - a. Provide signs at each fire door as required by CFC 703.2.1 when required by Fire Marshal.
 - b. Mounting: Door.
8. Electrical Rooms Signage:
 - a. Provide signs at rooms containing electrical control panels as required by CFC 6.5.3.1 and Fire Marshal.
 - b. Mounting: Door.
 - c. Fire Control Equipment Signage - FDS-#:
Provide signs at rooms containing shafts, electrical control panels, air conditioning systems, sprinkler risers and valves, and other fire detection/suppression elements per CFC 509.1, 605.3 and as required by Fire Marshal.
 - d. Mounting: Door.

2.15 EXTERIOR INFORMATIONAL AND DIRECTIONAL SIGNAGE

- A. Materials: Design and materials as indicated in drawings.
- B. Sign Message:
 1. Provide signage with message as indicated in drawings and as specified in Signage Message Schedule.
 2. Path of Travel Directional Signage:
 - a. Provide sign with International Symbol of Accessibility.
 - b. Provide directional arrow as required to indicate accessible route from parking to accessible entrance.

2.16 ACCESSIBLE PARKING INFORMATIONAL AND DIRECTIONAL SIGNAGE

- A. Materials: Design and materials as indicated in drawings.
- B. Sign Message:
 1. Provide signage with message as indicated in drawings and as specified in Signage Message Schedule.
 2. Standard Parking Space Signage:
 - a. Message: Sign identifying accessible parking space, in compliance with CBC 11B-502.6, and shall include symbol of accessibility.

- b. Mounting: [wall] [post]
 - 3. Van Accessible Parking Space Signage:
 - a. Message: Van Accessible in compliance with CBC 11B-502.6.
 - b. Mounting: [wall] [post]
 - 4. Parking Lot Entrance Signage:
 - a. Message: Sign identifying accessible parking, with tow away numbers, in compliance with CBC 11B-502.8.
 - b. Mounting: [wall] [post]
- 2.17 EXTERIOR ADDRESS NUMERALS
- A. Manufacturer: Gemini or equal.
 - B. Type: Cast metal numerals, complying with CFC 501.1 and local fire department address regulations.
 - C. Series: Cast Metal
 - D. Characteristics:
 - 1. Material: Aluminum, minimum 0.25-inch thickness
 - 2. Size: 2 inches thick x 4 inches minimum [12 inches] high
 - 3. Font: As shown in Wayfinding and District Standards, all numerals, 2-inch stroke dimension. Provide 7 numerals and one letter, using up to 7 different numbers as defined by Architect, at no additional cost.
 - 4. Face: Flat face.
 - 5. Mounting: Wall mounted, using manufacturers standard stainless-steel anchors and stand-off studs at each numeral.
 - 6. Finish: Painted, color as selected by Architect.
 - E. Sign Message: Building address numerals.
- 2.18 FABRICATION
- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - B. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - C. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - D. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - E. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - F. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - G. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

- H. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.
- I. Accurately fabricate signs and graphics to shape and dimension in strict accordance with shop drawings.
- J. Letters, symbols, and rules must be accurately reproduced for locations indicated on the drawings.
- K. Graphic panels to be free of waves, buckles and warps. The design and detailing of anchorages, connections and joints must allow for expansion and contraction over a temperature range for the material of 65 degrees C, without buckling, sealant joint failure, glass breakage, undue stress on members or anchors, and other detrimental effects.
- L. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into indicated sign surface to produce precisely formed copy, incised to uniform depth.
 - 1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
 - 2. Engraved Opaque Acrylic Sheet: Fill engraved graphics with manufacturer's standard enamel.
 - 3. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with manufacturer's standard enamel. Apply manufacturer's standard opaque background color coating to back face of acrylic sheet.
 - 4. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.
- M. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image to be free of rough edges.
- N. Subsurface-Etched Graphics: Reverse etch back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.
- O. Subsurface-Engraved Graphics: Reverse engrave back of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.
- P. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fish mouths.
- Q. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:
 - 1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. Subsequent changeable inserts are by Owner.
 - 2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. Subsequent changeable inserts are by Owner.
 - 3. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel. Subsequent changeable sign panels are by Owner.
- R. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
 - 1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish as specified on Drawings.
 - 2. Stainless-Steel Brackets: Factory finish brackets as specified on Drawings.

2.19 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.20 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
- B. Color Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.21 METALLIC-COATED STEEL FINISHES

- A. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A 780/A 780M.
- B. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the organic coating to be applied over it.
- C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm).

2.22 STEEL FINISHES

- A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, and prepare for coating according to coating manufacturer's written instructions.
 - 1. For Baked-Enamel or Powder-Coat Finish: After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.
- B. Factory Prime Finish: After surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.
- C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm).

2.23 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2. Directional Satin Finish: No. 4.
3. Dull Satin Finish: No. 6.
4. Reflective, Directional Polish: No. 7.
5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

PART 3 - EXECUTION - NOT USED

END OF SECTION 101423

SECTION 102113.17 - PHENOLIC-CORE TOILET COMPARTMENTS

GUIDELINES

1. *Verify panel grab bar support complies with CBC anchorage requirements. Provide reinforcement as required.*
2. *Specified compartment is conventional privacy dimensions. Consider use of enhanced privacy panel dimensions, reducing clearance at bottom and top of partition. Coordinate compartment accessibility dimensions if dimension from floor to bottom of panel is reduced.*
3. *Coordinate all dimensions with gender neutral multi-accommodation requirements.*
4. *Verify fire rating per DSA application of CBC Chapter 8.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Phenolic-core toilet compartments.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain phenolic-core toilet compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: **[25] [75]** or less.
 2. Smoke-Developed Index: 450 or less.
- B. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:
 1. Panels are able to withstand a concentrated load on grab bar of at least 250 lbf applied at any direction and at any point, without deformation of panel.
- C. Regulatory Requirements: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and CBC Chapter 8 and 11B for toilet compartments.

2.3 PHENOLIC-CORE TOILET COMPARTMENTS <Insert drawing designation>

- 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. Bobrick Washroom Equipment, Inc.
 2. or equal.
- B. Series: Standard Duraline CGL
- C. Toilet-Enclosure Style: Overhead braced .
- D. Urinal-Screen Style: Wall hung Overhead braced.

- E. Door, Panel, and Pilaster Construction: Solid phenolic-core material with melamine facing on both sides fused to substrate during manufacture (not separately laminated), and with eased and polished edges. Provide minimum 3/4-inch- thick doors and pilasters and minimum 1/2-inch- thick panels.
 - 1. Provide with no-sightline system consisting of door and pilaster lapped edges on strike side of door and door and pilaster lapped edges on hinge side of door (unless continuous hinge is used).
- F. Urinal-Screen Construction: Matching panel construction.
- G. Pilaster Shoes: Formed from stainless steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.
- H. Pilaster Sleeves (Caps): Formed from stainless steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.
- I. Brackets (Fittings):
 - 1. Full-Height (Continuous) Type: Manufacturer's standard design, stainless steel.
- J. Phenolic Compartment Finish: Two colors in each room.
 - 1. Dark-Core Phenolic: Manufacturer's standard dark color core and edge.
 - a. Facing Sheet Color: As selected by Architect from manufacturer's full range.

2.4 HARDWARE AND ACCESSORIES

- A. Door Hardware and Accessories, Heavy Duty: Manufacturer's heavy-duty institutional operating hardware and accessories.
 - 1. Material: Hinges, door latch, door keepers, clothes hooks, mounting brackets and door handles, 18-8, Type-304, heavy gauge stainless steel with satin finish.
 - 2. Door keeper: Stainless steel, 11 gauge.
 - 3. Doorstop: Provide 1040-10 door stop.
 - 4. Hardware: Theft-resistant, stainless-steel pin-in-head, torx screws, with threaded inserts are factory installed to secure door hinge and latch.
 - 5. Hinges: Bobrick 10002920/1002921 stainless-steel continuous, cam type that swings to a closed or partially open position that can be adjusted
 - 6. Latch and Keeper: Bobrick 1002612 slide type with occupancy indicator, heavy-duty surface-mounted cast-stainless-steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units with operable parts operable with one hand and do not require tight grasping, pinching, or twisting of the wrist.
 - 7. Coat Hook: Manufacturer's heavy-duty combination cast-stainless-steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
 - 8. Door Bumper: Manufacturer's heavy-duty rubber-tipped cast-stainless-steel bumper at out-swinging doors.

9. Door Pull: Manufacturer's heavy-duty cast-stainless-steel C-shaped pull at out-swinging doors. Provide pull on both sides of doors at compartments designated as accessible. Align handles on both sides with concealed fasteners - do not offset

- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with anti-grip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.5 MATERIALS

- A. Aluminum Castings: ASTM B26/B26M.
- B. Aluminum Extrusions: ASTM B221/B221M.
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- D. Stainless Steel Castings: ASTM A743/A743M.

2.6 FABRICATION

- A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Door Size and Swings: Unless otherwise indicated on Drawings, provide the following door sizes and swings:
 1. Ambulatory Accessible Compartments: 34-inch- wide, out-swinging door with a minimum 32-inch- wide clear opening.
 2. Wheelchair Accessible Compartments: 36-inch- wide, out-swinging door with a minimum 32-inch- wide clear opening.
 3. All Other Toilet Compartments: 24-inch- wide, in-swinging door.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 102239 - FOLDING PANEL PARTITIONS

GUIDELINES

1. *Review acoustical criteria and select appropriate panel system. Detail overhead flanking paths to maintain required acoustical performance. Note field testing requirement. Verify that expected field reduction aligns with specified value and acoustical criteria.*
2. *Panel weights dependent on acoustical values. Verify load imposed on structure with SEOR.*
3. *Verify floor level and flatness meets partition manufacturer criteria.*
4. *Motorized operation is specified for operator ease of operation and accessibility. Verify manual partition operation is considered accessible by DSA.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Electrically operated, acoustical panel partitions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Operable panel partitions are to withstand the effects of earthquake motions determined according to ASCE/SEI 7 as modified by CBC Chapter 16A..
 1. The term "withstand" means "the partition panels will remain in place without separation of any parts when subjected to the seismic forces specified."
- B. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
 1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E90, determined by ASTM E413, and rated for not less than the STC indicated.
 2. Noise-Reduction Requirements: Operable panel partition assembly, identical to partition tested for STC, tested for sound-absorption performance according to ASTM C423, and rated for not less than the NRC indicated.
 3. Noise-Isolation Requirements: Installed operable panel partition assembly, identical to partition tested for STC, tested for NIC according to ASTM E336, determined by ASTM E413, and rated for <Insert value>.
- C. NIC Testing: Owner will engage a qualified testing agency to perform tests and inspections.
 1. Testing Extent: Testing agency is to randomly select [one] <Insert number> operable panel partition installation(s) for testing.
 2. Testing Methodology: Perform testing of installed operable panel partition for noise isolation according to ASTM E336, determined by ASTM E413, and rated for not less than NIC indicated. Adjust and fit partitions to comply with NIC test method requirements.

- D. Fire-Test-Response Characteristics: Provide panels with finishes complying with one of the following as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 - 2. Fire Growth Contribution: Complying with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.
- 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 MOTORIZED OPERABLE ACOUSTICAL PANELS <Insert drawing designation>

- A. Operable Acoustical Panels: Partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
- B. Panel Operation: Electrically operated continuously hinged panels.
- C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
- D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
 - 1. Panel Width: Equal widths.
- E. STC: Not less than [50] [52][54].
- F. NRC: Not less than [0.60][0.90] Insert number.
- G. Panel Weight: <Insert value> maximum.
- H. Panel Thickness: Maximum dimension of 4-1/4 inches.
- I. Panel Materials:
 - 1. Steel Frame: Steel sheet, manufacturer's standard nominal minimum thickness for uncoated steel.
 - 2. Steel Face/Liner Sheets: Tension-leveled steel sheet, manufacturer's standard minimum nominal thickness for uncoated steel.
- J. Finish Facing: [Vinyl-coated fabric wall][acoustical finish][white board] .

2.3 PANEL FINISH FACINGS

- A. Description: Finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.
 - 1. Apply facings free of air bubbles, wrinkles, blisters, and other defects, with edges tightly butted, complying with Shop Drawings for location, and with no gaps or overlaps..
- B. Owner-Furnished Facing Material: <Insert requirements>.

FOLDING PANEL PARTITIONS

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- C. Vinyl-Coated Fabric Wall Covering: Manufacturer's standard, mildew-resistant, washable, vinyl-coated fabric wall covering; complying with WA-101, Type II-Medium Duty ; Class A.
 - 1. Total Weight: <Insert value>.
- H. Paint: Manufacturer's standard [factory-] [field-]painted finish.
 - 1. Color: Insert color.
- I. Cap-Trimmed Edges: Protective perimeter-edge trim with tight hairline joints concealing edges of panel and finish facing, finished as follows:
 - 1. Steel, Painted: Finished with manufacturer's color as selected by Architect from manufacturer's full range.
 - 2. Aluminum: Finished with manufacturer's standard clear anodic finish.
- J. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.4 SUSPENSION SYSTEMS

- A. Tracks: Steel mounted directly to overhead structural support, designed for operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
 - 1. Panel Guide: Aluminum guide on both sides of the track to facilitate straightening of the panels; finished with factory-applied, decorative, protective finish.
 - 2. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.
- B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.
 - 1. Multidirectional Carriers: Capable of negotiating intersections without track switches.
- C. Track Intersections, Switches, and Accessories: As required for operation, storage, track configuration, and layout indicated for operable panel partitions, and compatible with partition assembly specified. Fabricate track intersections and switches from steel or aluminum.
 - 1. T Intersections: Allow panels to pass through or change 90 degrees to another direction of travel.
 - 2. Multidirectional Switches: Adjustable switch configuring track into L, T, or X intersections and allowing panels to be moved in all pass-through, 90-degree change, and cross-over travel direction combinations.
 - 3. Center carrier stop.
- D. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.
- E. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.5 ELECTRIC OPERATORS

- A. Factory-assembled electric operation system of size and capacity recommended and provided by operable panel partition manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, control stations, control devices, and accessories required for operation. Include wiring from control stations to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
- B. Comply with NFPA 70.
- C. Control Equipment: Two push button control stations wired in series and located on opposite sides of the partition. Control stations shall be activated by key switch at stack end of partition. Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
- D. Motor Electrical Characteristics:
 - 1. Horsepower: <Insert value>.
 - 2. Volts: <Insert value>.
 - 3. Phase: <Insert value>.
 - 4. Hertz: 60.
- E. Obstruction-Detection Devices: Equip each motorized operable panel partition with indicated automatic safety sensor that causes operator to immediately stop and reverse direction.
 - 1. Sensor Edge: Contact-pressure-sensitive safety edge along partition's leading edge.
 - 2. Infrared Sensor System: Designed to detect an obstruction in partition's path and sound an audible alarm, without obstruction contacting partition.
- F. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop operable panel partition at fully extended and fully stacked positions.
- G. Emergency Release Mechanism: Quick disconnect-release of electric-motor drive system, permitting manual operation in event of operating failure.
- H. Electric Interlock: Equip each motorized operable panel partition with electric interlocks at locations indicated, to prevent operation of operable panel partition under the following conditions:
 - 1. On storage pocket door, to prevent operation if door is not in fully open position.

2.6 ACCESSORIES

- A. Pass Doors: Swinging door built into and matching panel [materials,] [construction,] [acoustical qualities,] finish and thickness, complete with frames and operating hardware. Hinges finished to match other exposed hardware.
 - 4. Pass-Door Hardware: Equip pass door with the following:
 - f. Latchset: Passage set complying with CBC Chapter 11B.
- B. Storage Pocket Door: Full height at end of partition runs to conceal stacked partition; of same materials, finish, construction, thickness, and acoustical qualities as panels; complete with operating hardware[and acoustical seals at soffit, floor, and jambs]. Hinges in finish to match other exposed hardware.
 - 1. Rim Lock, Key Operated: Key-operated lock cylinder[, keyed to master key system,] to secure storage pocket door in closed position. Include two keys per lock.
- C. Work Surfaces: Quantities, placement, and size indicated.
 - 1. Surface: Porcelain steel marker/projection surface.
 - 2. Trim: [Aluminum slip-on or snap-on trim with no visible screws or exposed joints and with corners mitered to a neat, hairline joint] <Insert description>.

FOLDING PANEL PARTITIONS

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PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 102600 - WALL PROTECTION

GUIDELINES

1. *Evaluate corner guard conditions based on impact. Select based on backpacks, carts, and other educational environment conditions.*
2. *While corner guards represent design and cost impact, ongoing maintenance considerations are also important.*
3. *Wall protection system provides substantial benefit in corridors. Consider wall protection sheet with graphics as an additional way finding feature. Select thickness based on impact considerations and coordinate available colors.*
4. *Coordinate termination details at floor base, at splices, and ceiling.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Corner guards.
 2. Impact Resistant rigid sheet wall protection.

PART 2 - PRODUCTS

2.1 CORNER GUARDS

- 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. Construction Specialties, Inc.
- B. Type: Surface-Mounted, Resilient, Plastic Corner Guards Assembly consisting of snap-on plastic cover installed over continuous retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.
- C. Series: SM-20N
- D. Characteristics:
1. Cover: Extruded rigid plastic, PETG, non-PVC, 0.078 inches thick.
 2. Size: Nominal 3-inch- long leg and 1/4-inch corner radius.
 3. Height: 8 feet.
 4. Retainer: Minimum 0.060-inch- thick, one-piece, extruded aluminum.
 5. Retainer Clips: Manufacturer's standard impact-absorbing clips.
 6. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
 7. Impact Resistance: Minimum 25.4 ft-lbf/in. of notch when tested according to ASTM D 256, Test Method A.
 8. Chemical and Stain Resistance: Tested according to ASTM D 543 .
- E. Fire/Life safety/Habitability
1. Self-extinguishing when tested according to ASTM D 635.
 2. Flame-Spread Index: 25 or less.
 3. Smoke-Developed Index: 450 or less.
- F. Color and Texture: As selected by Architect from manufacturer's full range.

2.2 CORNER GUARD – METAL

- A. Surface-Mounted, Metal Corner Guards: Fabricated from one-piece, formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
- B. 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. Construction Specialties, Inc.
- C. Material: Stainless steel, Type 304.
 - 1. Thickness: Minimum 0.0781 inch.
 - 2. Finish: Directional satin, No. 4.
 - 3. Wing Size: Nominal 3-1/2 by 3-1/2 inches.
 - 4. Corner Radius: 1/8 inch.
 - 5. Mounting: Oval head, countersunk screws through factory-drilled mounting holes.

2.3 IMPACT -RESISTANT RIGID SHEET WALL PROTECTION

- 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. Construction Specialties..
- B. Type: Rigid PETG sheet material
 - 1. [reverse printed with customer supplied digital graphics.]
- C. Series: Acrovyn [digital printed.]
- D. Characteristics:
 - 1. Plastic Sheet: Non-PVC, PETG, textured, chemical- and stain-resistant, high-impact-resistant with integral color throughout; thickness as indicated.
 - 2. Size: As shown on drawings.
 - 3. Impact Resistant Sheet Thickness: [0.040][0.060][0.075] inch.
 - 4. Height: As indicated.
 - 5. Trim and Joint Moldings: Aluminum or Non-PVC extruded plastic as indicated on drawings.
 - 6. Mounting: Adhesive, VOC and Class A fire resistance compliant.
 - 7. Abrasion Resistance: Resistance to abrasion per ASTM D 4060.
 - 8. Impact Resistance: Maximum indentation of 3/8 inches, 66.113 ft-lb impact per ASTM F 476.
 - 9. Chemical and Stain Resistance: Tested according to ASTM D 543.
- E. Custom Digital Printing:
 - 1. Process: Reverse printed custom high-definition digital files, reverse printed on clear PETG sheet and sealed with a protective backer.
 - 2. Copyright Clearance: Owner will provide copyright clearance to print with custom graphic. Reuse of graphic by Inpro for non-project applications prohibited.
 - 3. Owner will provide digital file in format as required for printing.
- F. Fire/Life Safety/Habitability
 - 1. Self-extinguishing when tested according to ASTM D 635.
 - 2. Flame-Spread Index – sheet and particle board: 25 or less per ASTM E84.
 - 3. Smoke-Developed Index – sheet and particle board: 450 or less per ASTM E84.
 - 4. Urea Formaldehyde: Particleboard shall be CARB compliant with no added urea formaldehyde.
 - 5. Air Quality: Panel shall be Green guard certified for Children and Schools.

- G. Color and Texture: As indicated by manufacturer's designations.
 - 1. Digital Graphic Image: Owner supplied custom graphic.
 - 2. Sheet Texture: Matte smooth.
 - 3. Trim Color: As selected by Architect matching sheet.

PART 3 - EXECUTION – NOT USED

END OF SECTION 102600

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SECTION 102800 – TOILET, SHOWER AND MISCELLANEOUS ACCESSORIES

GUIDELINES

- 1. Verify anchorage detail for all accessories. Code required load capability may not be achieved in all panel materials without accessories or reinforcement.*
- 2. Consider impact on fire rating when selecting recessed accessories.*
- 3. Coordinate with District on current vendor arrangements for soap and paper related accessories designated as "CLEA".*
- 4. Monitor selections and placement to avoid exceed 4 inch projections into the accessible path.*
- 5. Shower seat load capacity selected for impact load.*
- 6. Review District approach regarding hands free accessories.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Toilet, shower and washroom accessories.
 2. Under-lavatory and under-sink guards.
 3. Custodial accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Toilet Shower and Miscellaneous Accessories: Unless otherwise specified, and subject to compliance with requirements, provide products by one of the following, or equal:
 1. Bobrick Washroom Equipment, Inc - Basis of Design
 2. TSM.
- B. Under-lavatory Guards: Subject to compliance with requirements, provide the following, or equal:
 1. TrueBro LavGard 2 or equal.
- C. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the "Toilet and Bath Accessory Schedule" at the end of Part 3.

2.2 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Brass: ASTM B 19, leaded and unleaded flat products; ASTM B 16, rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.
- C. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359-inch minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.
- D. Galvanized Steel Sheet: ASTM A 653/A 653M, G60.
- E. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal.
- F. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.
- G. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.

- H. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- I. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.3 TOILET ACCESSORY FABRICATION

- A. General: One, maximum 1-1/2-inch- diameter, unobtrusive stamped manufacturer logo, as approved by Architect, is permitted on exposed face of accessories. On interior surface not exposed to view or back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.
- B. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.
- C. Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.
- D. Framed Glass-Mirror Units: Fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation.
- E. Provide galvanized steel backing sheet, not less than 0.034 inch and full mirror size, with non-absorptive filler material. Corrugated cardboard is not an acceptable filler material.
- F. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:
 - 1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - 2. Heavy-duty wall brackets of galvanized steel equipped with concealed locking devices requiring a special tool to remove.
- G. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to District.

2.4 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

2.5 TOILET AND MISCELLANEOUS ACCESSORY SCHEDULE

- 1. Piping Protection - Under lavatory and under sink Piping Guard – PP-1
 - a. TrueBro Lav Guard 2, for all piping, trap, and stops.
 - b. Provide specified guard at all sinks and lavatories, irrespective of accessibility designation.
- 2. Grab Bar
 - a. GB-1 – Bobrick B-5806 Series – 48-inch length.
 - b. GB-2 – Bobrick B-5806 Series – 42-inch length.

- c. GB-3 – Bobrick B-5806 Series – 36-inch length.
 - d. GB-4 – Bobrick B-5806 Series – 24-inch length.
- 3. Shower Seat
 - a. FSB-1: Reversible Solid Phenolic Folding Shower Bench. Bobrick B-5192 or equal, 500 lb capacity.
- 4. Shower Rod and Curtain
 - a. SCR: Shower Curtain Rod. Bobrick Heavy-duty 6047 or equal.
 - b. SC: Vinyl Shower Curtain. Bobrick 204 or equal. Provide hooks equal to Bobrick 204-1.
- 5. Shower Soap Dish
 - a. RSD-1: Recessed Shower Soap Dish. Bobrick B-4380 or equal.
- 6. Toilet Paper Holder
 - a. TPH-1 – Bobrick 2892.
 - b. TPH-2 - Bobrick B-3888, recessed
 - c. TPH – 3 - Bobrick B-4288, surface mount
- 7. Seat Cover Dispenser
 - a. SCD-1 – Bobrick 301.
 - b. SCD-2 - CLEA Item # FH33-B, surface mount
- 8. Sanitary products dispenser
 - a. SPD-1 – Bobrick 370634C, coin free dispenser.
 - b. SPD-2 - Bobrick B4706, recessed, coin free operation
- 9. Sanitary napkin disposal
 - a. SND-1 – Bobrick 353.
 - b. SND-2 - Bobrick B-270, surface mount
 - c. SND-3 - Bobrick B-35303 Recessed
- 10. Combination Units
 - a. MID 1 - Bobrick B-357 Classic Series Partition-Mounted Seat-cover Dispenser, Sanitary Napkin Disposal, and Toilet Tissue Dispenser
 - b. MID 2 - Bobrick B3474 Classic Series Recessed Seat-Cover and Toilet Tissue Dispenser
 - c. MID 3 - Bobrick B-3574 Classic Series Recessed Seat-Cover Dispenser, Sanitary Napkin Disposal and Toilet Tissue Dispenser

11. Soap Dispenser
 - a. SD-1 – Bobrick B-2013 Hands Free, battery, wall mount.
 - b. SD-2 – Larson XLE-MD-DF-AD-LS-120V Hands Free, 120 VAC, wall mount, with power cord.
12. Mobile Device Holder: Bobrick B-635
13. Diaper Changing Station:
 - a. DCS-1: Bobrick/Koala KB-310 -SSWM, Horizontal, stainless steel.
14. Framed Mirror
 - a. M-1 - Bobrick B-165, [18 x 36][size as selected by District] with safety backing film complying with 16 CFR 1201 over back of glass.
15. Hands Free Dryer
 - a. HD-1 – Excel TA – SB-H with HEPA filter. XL-SB, 120 VAC, maximum 4-inch projection.
16. Paper Towel Dispenser:
 - a. PTD-1 - CLEA Item # CL500, recessed
 - b. PTD-2 – Bobrick B 2860 at janitors
17. Waste Receptacle
 - a. WR-1 – Bobrick B-35643 Recessed
18. Hook
 - a. CH-1 – Bobrick B-542 Surface Mounted
 - b. CH-2- Bobrick B-682, surface mount
19. Mop Rack / Utility Shelf:
 - a. MR-1 - Bobrick B-239 x 34 at Janitor/EVS rooms.
 - b. MS-2- GAMCO MS SHELF, 4 inches deep, length as shown, surface mount.
20. Waste Receptacle:
 - a. WR-1– Bobrick B-3644 recessed waste receptacle for 4-inch walls.

PART 3 - EXECUTION – NOT USED

END OF SECTION 102800

SECTION 104413 - FIRE PROTECTION CABINETS

GUIDELINES

1. *Coordinate locations as required for code compliant spacing and travel distance.*
2. *District preference is for fully recessed cabinets. Select fire rated cabinet at fire rated walls.*
3. *Verify fire extinguisher manufacturer with District.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Fire protection cabinets: Fire extinguisher
 2. Portable fire extinguishers.

PART 2 - PRODUCTS

2.1 FIRE PROTECTION CABINET

- A. Manufacturer:
1. Guardian Fire Equipment
 2. Or equal.
- B. Type: Steel, non-locking, non-rated.
1. Cabinet box with style of trim indicated.
- C. Series: 1800
- D. Characteristics – FEC-1- Recessed
1. Model: 1820 sized to accommodate specified extinguisher.
 2. Cabinets: Construct cabinets fabricated from 0.063-inch- thick, cold-rolled steel sheet lined. Provide factory-drilled mounting holes
 - a. Provide fire rated double wall cabinet, listed for 1- and 2-hour conditions, at fire rated walls.
 3. Shelf: Same metal and finish as cabinet.
 4. Edge Trim: 3 /8-inch backbend depth.
 5. Cabinet Trim Material: Steel.
 6. Door Material: Steel, 20 gage.
 - a. Door Style: Provide Style A, Full vision panel, acrylic, door.
 - b. Marking: "FIRE EXTINGUISHER", die cut letters, vertical.
 7. Door Hardware:
 - a. Provide door pull and friction latch.
 - b. Provide continuous hinge, of same material and finish as door panel, with stainless steel pin, permitting door to open 180 degrees.
 8. Finish:
 - a. Manufacturer's standard baked enamel paint.
 - b. Color: As selected by Architect from manufacturer's full range.

E. Characteristics – FEC-2- Surface Mount

1. Model: 1850, sized to accommodate specified extinguisher.
2. Cabinets: Construct cabinets fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined. Provide factory-drilled mounting holes.
3. Shelf: Same metal and finish as cabinet.
4. Rolled-Edge Trim: 1 1/2-inch backbend depth, rolled radius edge.
5. Cabinet Trim Material: Steel.
6. Door Material: Steel, 20 gage.
 - a. Door Style: Provide Style A, Full vision panel, acrylic, door.
 - b. Marking: "FIRE EXTINGUISHER", die cut letters, vertical.
7. Door Hardware:
 - a. Provide FP - recessed door pull and friction latch.
 - b. Provide continuous hinge, of same material and finish as trim, with brass pin, permitting door to open 180 degrees.
8. Finish:
 - a. Manufacturer's standard baked-enamel paint for cabinet interior.
 - b. Door and Frame: Polyester paint finish, white color.

2.2 FIRE EXTINGUISHER

- A. Fire extinguisher: Unless specified otherwise, provide Guardian or equal, Multipurpose dry chemical, UL size as required by DSA Fire/Life Safety and cabinet size.
1. Provide K type at kitchen and similar conditions as required by Fire Code.

2.3 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard boxtub with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
 2. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION – NOT USED

END OF SECTION 104400

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SECTION 105113 METAL LOCKERS

GUIDELINES

1. *Coordinate tier designations, locker dimensions, and accessories with District departments.*
2. *Welded lockers are specified for long-term durability. Lockers used infrequently may be specified as knocked down for reduced cost.*
3. *Anchor locker assemblies in compliance with CBC Chapter 16A seismic criteria.*
4. *Confirm lock strategy and type with District.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Welded general purpose lockers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and the California Building Code, Chapter 11B.

2.2 WELDED LOCKERS

- 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. ASI Storage Solutions.
 2. DEBOURGH ALL-AMERICAN LOCKERS.
 3. List Industries Inc.
 4. Lyon
- B. Sizes: Provide locker configuration as follows:
 1. Single Tier: <12 inches wide x 18 inches deep x 36 inches high>
 2. Double Tier: <12 inches wide x 18 inches deep x 36 inches high.>
 3. Four-Tier: <18 inches wide x 18 inches deep x 18 inches high.>
 4. Accessible Lockers: Locate bottom shelf no lower than 15 inches above the floor. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor. Provide an accessible, approved lock and a decal showing the international symbol of accessibility.
- C. Doors: One piece; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
 1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.
 2. Door Style: [Unperforated panel.] [Vented panel as follows:]
 - a. Louvered Vents: No fewer than [six louver openings at top and bottom for single-tier] [three louver openings at top and bottom for double-tier] [two louver openings at top and bottom, or three louver openings at top or bottom, for triple-tier] <Insert configuration> lockers.
 - b. Security Vents: Manufacturer's standard stamped horizontal or vertical.
 - c. Perforated Vents: [Manufacturer's standard shape and configuration] <Insert shape and configuration>.

- D. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
 - 1. Tops, Bottoms, and Sides: 0.060-inch (1.52-mm) nominal thickness.
 - 2. Backs: 0.048-inch (1.21-mm) nominal thickness.
 - 3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.
- E. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.
- F. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.
 - 1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and pre-locking.
 - a. Latch Hooks: Equip doors 48 inches and higher with three latch hooks and doors less than 48 inches high with two latch hooks; fabricated from 0.105-inch nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
 - b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact and incorporating a pre-locking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
- G. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch (9 mm) high.
- H. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.
- I. Coat Rods: 1-inch- (25-mm-) diameter steel, chrome finished Manufacturer's standard.
- J. Continuous Zee Base: Fabricated from, manufacturer's standard thickness, but not less than 0.060-inch (1.52-mm) nominal-thickness steel sheet.
 - 1. Height: 4 inches (102 mm).
- K. Continuous Sloping Tops: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet, with a pitch of approximately 20 degrees.
- L. Trim
 - 1. Closures: Vertical-end type.
 - 2. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
 - 3. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
 - 4. Boxed End Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
 - 5. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of non recessed metal lockers; finished to match lockers.
- M. Materials:
 - 1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
 - 2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
- N. Finish: Baked enamel or powder coat.
- O. Color: As selected by Architect from manufacturer's full range.

2.3 LOCKS

- A. Built in combination master lock at non-accessible lockers.

2.4 DIGITAL LOCKING MECHANISM AT ACCESSIBLE LOCKER

- A. Manufacturer: Digilock or equal.
- B. Series: Axis Standard, with pull handle.
 - 1. Function: Assigned Use.
 - 2. Accessibility: Provide (5) User Keys for each accessible locker.
 - 3. Locking: 1/2-inch deadbolt lock, coordinated with locker frame design.
- C. Finish: Brushed Nickel.
- D. Programming: Provide (5) manager keys and (5) programming keys.

2.5 FABRICATION

- A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burs.
 - 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
 - 2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
- B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.
- C. Equipment: Provide each locker with an identification plate and the following equipment:
 - 1. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
- D. Accessible Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches above the floor.
 - 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- E. Continuous Zee Base: Fabricated in lengths as long as practical to enclose base and base ends; finished to match lockers.
- F. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
 - 1. Sloping-top corner fillers, mitered.
- G. Recess Trim: Fabricated with minimum 2-1/2-inch face width and in lengths as long as practical; finished to match lockers.
- H. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
- I. Boxed End Panels: Fabricated with 1-inch-wide edge dimension and designed for concealing fasteners and holes at exposed ends of non recessed metal lockers; finished to match lockers.
 - 1. Provide one-piece panels for double-row (back-to-back) locker ends.
- J. Finished End Panels: Fabricated to conceal unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of non recessed metal lockers; finished to match lockers.
 - 1. Provide one-piece panels for double-row (back-to-back) locker ends.
- K. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

2.6 ACCESSORIES

- A. Fasteners: Zinc- or nickel-plated steel, slot less-type, exposed bolt heads; with self- locking nuts or lock washers for nuts on moving parts.
- B. Accessible Sign: Provide 6-inch square ISA symbol on accessible locker.
- C. Anchors: Material, type, and size required for secure anchorage to each substrate.
 - 1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls, and elsewhere as indicated, for corrosion resistance.
 - 2. Provide toothed steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION – NOT USED

END OF SECTION 105113

SECTION 107000 – ALUMINUM SUNSHADE FABRICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Provide fixed custom sunshades as shown on the drawings and as specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:

1. Construction Specialties (Basis of Design)
2. Or equal.

B. Series: Construction Specialties CS Model 100-3 Infill Canopy.

C. Type: Extruded aluminum airfoil design with integral screw splines, with factory assembled blades to outriggers using stainless steel, type F, thread cutting screws through internal screw slots in blades. Welding is not acceptable. Blades shall be mechanically secured to allow for replacement in case of damage. Fasteners to be hex head.

D. Configuration:

1. Outrigger: 1/4-inch custom profile flat aluminum plate members, cut to match blade profile exactly.
2. Blade: CS Model 01-08-435
3. Size: 14 inches high by 2 3/8 inch.
4. Mounting Bracket: Provide all aluminum mounting brackets, hardware, and fasteners. Provide stainless steel 300 Series fasteners.

2.2 PERFORMANCE REQUIREMENTS

A. General: When tested in accordance with cited test procedures, meet or exceed the following performance criteria:

1. Structural loads.
2. Thermal movements.
3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
4. Dimensional tolerances of building frame and other adjacent construction.
5. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferred to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - d. Noise or vibration created by wind and thermal and structural movements.
 - e. Loosening or weakening of fasteners, attachments, and other components.

B. Structural Loads

1. Wind Loads: As indicated on Drawings.
 - a. Basic Wind speed = 115 mph
 - b. Exposure: C
 - c. Internal Pressure Coefficient: $GC_{pi} = 0.18$
 - d. Design Wind Pressure: As shown on Structural Drawings for specific zones.
2. Seismic Loads: Design assemblies to comply with:
 - a. ASCE 7, as referenced in the California Building Code.
 - b. California Building Code, including Chapters 16A and 24.
 - c. Component Importance Factor is 1.25.
 - d. Occupancy Category: III
3. Test Duration: As required by design wind velocity but not less than 10 seconds.

C. Structural-Test Performance – Deflection of Framing Members: Provide glazed aluminum curtain-wall systems tested according to ASTM E 330 as follows:

1. Deflection Normal to Wall Plane: When tested at both positive and negative load, deflection is limited to 1/175 of clear span, or 3/4 inch, whichever is less.

D. Thermal Movements: Provide glazed aluminum curtain-wall systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Test Performance: No buckling, stress on glass, glazing-edge seal failure, sealant failure, excess stress on curtainwall framing, anchors and fasteners, or reduction of performance when tested according to AAMA 501.5.
 - a. Test High Exterior Ambient Air Temperature: That which produces an exterior metal surface temperature of plus 180 deg F.
 - b. Test Low Exterior Ambient Air Temperature: minus 10 deg F.
 - c. Test Interior Ambient Air Temperature: 70 deg F.

2.3 MATERIALS

- A. Aluminum Extrusions: ASTM B 211, Alloy 6063-T52.
- B. Clip Angles: Structural grade aluminum.
- C. Fastenings: Aluminum or stainless steel. Provide types, gauges and lengths to suit unit installation conditions.
- D. Anchors and Inserts: Use non-ferrous metal or hot-dip galvanized anchors and inserts for installation and elsewhere as required for corrosion resistance. Use stainless steel or lead expansion bolt devices for drilled-in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.4 FABRICATION, GENERAL

- A. Provide sunshade of design, materials, sizes, depth, arrangement, and metal thickness as indicated or as required for optimum performance with respect to strength; durability; and uniform appearance.
- B. Include all additional support, anchorage, and accessories required for complete assembly and installation.

2.5 ALUMINUM FINISH

- A. General: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes in factory after products are assembled. Protect finishes on exposed surfaces prior to shipment. Remove scratches and blemishes from exposed surfaces which will be visible after completing finishing process.
- B. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: As selected by Architect from complete PPG Duranar line.

PART 3 - EXECUTION – NOT USED

END OF SECTION 107000

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SECTION 115000 – EDUCATIONAL EQUIPMENT

GUIDELINES

- 1. Educational equipment includes all equipment, appliances, and similar elements typically provided by the Owner and installed by the Contractor.*
- 2. Where indicated, Section also includes equipment furnished and installed by Contractor.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of Educational equipment is indicated on Equipment Schedules.
- B. Types of Educational equipment required are defined in Educational Equipment Binder, issued under separate cover.
- C. Provide all labor, materials, and equipment required to install Owner Furnished/Contractor Installed (OF/CI) and Contractor Furnished/Contractor Installed (CF/CI) Educational equipment as scheduled on Drawings and this Section.
 1. In addition, review Binder and coordinate all requirements necessary for Owner to install and make operational items identified as Owner Furnished / Owner Installed (OFOI), including power, data, plumbing connections.
- D. Work includes site assembly of equipment items as required.
- E. Work of this Section includes assembly and installation of equipment, including internal wiring and piping, up to designated points of supply connections as indicated on Drawings.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Equipment Requiring Mechanical Connections: Internal piping factory installed and shall terminate at openings approximately flush with the back of equipment.
- B. Equipment Requiring Electrical Connections: Internal wiring factory installed and shall terminate in junction box at back of equipment, or be equipped with power cord and plug, as indicated.

2.2 EDUCATIONAL EQUIPMENT

- A. Extent of Owner Furnished/Contractor Installed and Contractor Furnished/Contractor Installed equipment is scheduled on the Drawings and is further described in the Educational Equipment Product Data issued with the Drawings and Project Manual.
- B. Accessories: Provide rough-in hardware, supports and connections, attachment devices, closure trim, and related accessories required for a complete installation.

2.3 EQUIPMENT SCHEDULE

- A. Review detailed Equipment Schedule shown on drawings and in Equipment Binder for access, size, and utility and service connections. Provide equipment in accordance with schedule of OF/OI, OF/CI, and CF/CI scope.

2.4 OTHER MATERIALS

- A. Provide all other materials, not specifically described but required for complete and proper installation of this work, as selected by the contractor and subject to the approval of the Architect.

PART 3 - EXECUTION – NOT USED

END OF SECTION 117000

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SECTION 122413 - ROLLER WINDOW SHADES

GUIDELINES

1. *DSA requires accessible shades, which effectively translates into motorized units. Carefully evaluate strategies involving signage, work stations, and other approaches to justify use of manual shades.*
2. *Verify SFM listing for fabrics.*
3. *Evaluate cost trade off based on motor type (AC or DC/Low Voltage).*
4. *Coordinate motor capacity to operate multiple shades off one motor.*
5. *Define control type and location.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Manually operated roller shades with [single [double] rollers.
 2. Motor-operated roller shades with single [double] rollers.
 3. Motors, control systems, pockets, and accessories.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Shade Cloth Fire-Test-Response Characteristics: Documentation demonstrating material passes NFPA 701-99 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.
1. State Fire Marshal Listing: In addition to NFPA 701 testing, provide documentation demonstrating material is listed as an approved fabric by the California State Fire Marshal in compliance with Title 19, CCR testing requirements. Materials tested and listed shall be identical to products proposed for use.
 2. Fire-Test-Response Characteristics: Where fabrics are not currently listed, test fabric and file as required to obtain California State Fire Marshal listing.
- B. Shade Cloth Anti-Microbial Characteristics: 'No Growth' per ASTM G 21 results for fungi ATCC9642, ATCC9644 and ATCC9645, and E2180.
- C. Accessibility and Safety Standards:
1. Comply with accessible operation under 2010 ADA Standards and California Building Code Section 11B-309.4.
 2. CPSC Compliance: Comply with current Federally mandated CPSC (Consumer Products Safety Commission) safety standards at time of manufacturing.
 3. Chain tensioning device shall comply with ANSI/WCMA A100.1-2022.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturer offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Mechoshade
 2. Or equal.

- B. Basis-of-Design Product: Subject to compliance with requirements, provide the following or comparable product: MechoShade Systems, Inc. Mecho/5x System.
- C. Application: Use of manual shades is limited to locations that do not require accessible operation under 2010 ADA Standards and California Building Code Section 11B-309.4.
- D. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Lifting Force: 3.5 to 8.5 pounds (1.6 to 3.9 kg) for shade assemblies with a shade band hanging weight, not including mounting hardware, of 30 pounds (13.6 kg).
 - 2. Bead Chains: Stainless steel.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Chain tensioner, sill mounted.
- E. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 - 1. Roller Drive-End Location: As indicated on Drawings Insert requirements.
 - 2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
 - 3. Shadeband-to-Roller Attachment: Removable spline fitting into integral channel in tube.
 - 4. Shade band shall be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
 - 5. Roller tubes shall be capable of being removed and reinstalled without affecting roller shade limit adjustments.
- F. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- G. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
 - 1. Multiple Shade Band Operation: Provide hardware as necessary to operate more five shade bands, up to 360 inches (9144 mm) wide; depending on fabric weight, using a single clutch operator.
 - 2. Radiused Center Support Brackets: Provide brackets and connectors for radiused window applications.
 - 3. Maximum Offset: Eight degrees on each side for a 16 degree total offset.
- H. Shadebands:
 - 1. Shadeband Material: [Light-filtering fabric][Light-blocking fabric.]
 - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shade band material.
- I. Installation Accessories:
 - 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than height indicated on Drawings.
3. Endcap Covers: To cover exposed endcaps.
4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than height indicated on Drawings.
 - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
 - a. Closure-Panel Width: As indicated on Drawings.
6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
8. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 MOTOR-OPERATED, SINGLE-ROLLER SHADES

- 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: Mechoshade
 2. Or equal.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the following or comparable product:
 1. MechoShade Systems, Inc. ElectroShade with WhisperShade IQ2 EDU.
- C. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-rewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
 1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Electric Motor: As specified in this Section, tubular, enclosed in roller.
 - a. Motor Basis of Design: MechoShade WhisperShade IQ2+EDU System.
 - b. Electrical Characteristics: 120 VAC, unless otherwise indicated on Drawings.
 - c. Listing Label and Motor Rating: Visible for inspection without dismantling of shade assembly to remove motor or EDU from shade roller tube.

- d. Motor Size and Configuration: As recommended by manufacturer for type, size, and arrangement of shades. Based on shade weight and within each shade group, combine multiple shadebands on a single motor to reduce required power connections
 - e. Line voltage power supply connection equipped with locking disconnect plug assembly furnished with shade motor.
 - f. Motor Rated Speed: The same nominal speed for shades in the same room.
 - g. Audible Noise: 46 dBA measured 3 ft (914 mm) from motor unit, depending on motor torque.
 - h. 24 VDC as specified in this Section. Maximum Total Shade Width: As required to operate roller shades indicated.
 - i. Maximum Shade Drop: As required to operate roller shades indicated.
 - j. Maximum Weight Capacity: As required to operate roller shades indicated.
3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide remote-control activation of shades as specified in this Section
- a. Control Basis of Design: MechoShade IQ Decorator Switch.
 - b. Control Station: Maintained contact, five -position, rocker-style, wall-switch-operated control station with open, close, and three presets for vision control shades and two position for room darkening/blackout control as required.
 - 1) Preset positions: Customizable to any position between and including defined upper and lower limits (initially defaults to 25, 50, and 75 percent of shade travel).
 - c. Color: As selected by Architect from manufacturer's full range, unless otherwise indicated on Drawings.
 - d. Keyed Control Station: Keyed, momentary-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
 - e. Individual Switch Control Station: Momentary-contact, wall-switch-operated control station with open, close, and center off functions.
 - 1) Switch Positions: Three.
 - f. Group Control Station: Momentary-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
 - g. Individual/Group Control Station: Momentary-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
 - h. Color: As selected by Architect from manufacturer's full range.
- D. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
- 1. Roller Drive-End Location: Right side of interior face of shade Left side of interior face of shade.
 - 2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
 - 3. Shadeband-to-Roller Attachment: Removable spline fitting into integral channel in tube.
 - 4. Shade band shall be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
 - 5. Roller tubes shall be capable of being removed and reinstalled without affecting roller shade limit adjustments.

- E. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
 - 1. Provide shade hardware system that allows for field adjustment of motor or replacement of any operable hardware component without requiring removal of brackets, regardless of mounting position (inside, or outside mount).
 - 2. Provide shade hardware system that allows for operation of multiple shade bands offset by a maximum of 8-45 degrees from motor axis between shade bands (4-22.5 degrees) on each side of the radial line, by a single shade motor (multi-banded shade, subject to manufacturer's design criteria).
 - a. Multiple Shade Operation: Provide hardware as necessary to operate more than one shade using a single motor.
 - b. Radiused Center Support Brackets: Provide brackets and connectors for radiused window applications.
 - 3. Maximum Offset: 22.5 degrees on each side for a 45-degree total offset.
 - 4. Maximum Offset: 8 degrees on each side for a 16-degree total offset.
- F. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to five inline rollers that are operated by one roller drive-end assembly.
- G. Shadebands:
 - 1. Shadeband Material: as specified and as indicated on drawings.
 - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
- H. Installation Accessories:
 - 1. Front Fascia where shown: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches .
 - 2. Exposed Headbox where shown: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard in height required to enclose roller and shadeband assembly when shade is fully open, but not less than as indicated on Drawings.
 - 3. Endcap Covers: To cover exposed endcaps.
 - 4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than height indicated on Drawings.
 - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
 - 5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
 - a. Closure-Panel Width: As indicated on Drawings.

6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
8. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 MOTOR-OPERATED, DOUBLE-ROLLER SHADES

- 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: Mechoshade
 2. Or equal.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the following or comparable product:: MechoShade Systems, Inc. ElectroShade with WhisperShade IQ2 EDU
- C. Motorized Operating Systems: Provide factory-assembled, shade-operator systems of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
 1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Electric Motor: Manufacturer's standard tubular, enclosed in rollers.
 - a. Electrical Characteristics: .
 - 1) 120 VAC as specified in this Section
 - 2) 24 VDC as specified in this Section.
 3. Electric Motor: As specified in this Section. Tubular, enclosed in roller.
 - a. Motor Basis of Design: MechoShade WhisperShade IQ2+EDU System.
 - b. Electrical Characteristics: 120 VAC, unless otherwise indicated on Drawings.
 - c. Listing Label and Motor Rating: Visible for inspection without dismounting of shade assembly to remove motor or EDU from shade roller tube.
 - d. Motor Size and Configuration: As recommended by manufacturer for type, size, and arrangement of shades. Based on shade weight and within each shade group, combine multiple shadebands on a single motor to reduce required power connections
 - e. Line voltage power supply connection equipped with locking disconnect plug assembly furnished with shade motor.
 - f. Motor Rated Speed: The same nominal speed for shades in the same room.
 - g. Audible Noise: 46 dBA measured 3 ft (914 mm) from motor unit, depending on motor torque.
 - h. Maximum Total Shade Width: As required to operate roller shades indicated.
 - i. Maximum Shade Drop: As required to operate roller shades indicated.
 - j. Maximum Weight Capacity: As required to operate roller shades indicated.
 4. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting, unless otherwise indicated on Drawings. Provide as specified in this Section. the following for remote-control activation of shades:
 - a. Control Basis of Design: MechoShade IQ Decorator Switch.

- b. Control Station: Maintained contact, five -position, rocker-style, wall-switch-operated control station with open, close, and three presets for vision control shades and two position for room darkening/blackout control as required.
 - 1) Preset positions: Customizable to any position between and including defined upper and lower limits (initially defaults to 25, 50, and 75 percent of shade travel).
 - c. Color: As selected by Architect from manufacturer's full range, unless otherwise indicated on Drawings.
 - 5. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
 - a. Keyed Control Station: Keyed, momentary-contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
 - b. Individual Switch Control Station: Momentary-contact, wall-switch-operated control station with open, close, and center off functions.
 - 1) Switch Positions: Three.
 - c. Group Control Station: Momentary-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
 - d. Individual/Group Control Station: Momentary-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
 - e. Color: As selected by Architect from manufacturer's full range.
- D. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shades for service.
 - 1. Double-Roller Mounting Configuration: Offset, outside shade over and inside shade under.
 - 2. Inside Roller:
 - a. Drive-End Location: Right side of interior face of shade Left side of interior face of shade.
 - b. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
 - 3. Outside Roller:
 - a. Drive-End Location: Right side of interior face of shade Left side of interior face of shade.
 - b. Direction of Shadeband Roll: Reverse, from front (interior face) of roller.
 - 4. Shadeband-to-Roller Attachment: Removable spline fitting into integral channel in tube.
 - 5. Shade band shall be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
 - 6. Roller tubes shall be capable of being removed and reinstalled without affecting roller shade limit adjustments.
- E. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.
 - 1. Provide shade hardware system that allows for field adjustment of motor or replacement of any operable hardware component without requiring removal of brackets, regardless of mounting position (inside, or outside mount).

2. Provide shade hardware system that allows for operation of multiple shade bands offset by a maximum of 8-45 degrees from motor axis between shade bands (4-22.5 degrees) on each side of the radial line, by a single shade motor (multi-banded shade, subject to manufacturer's design criteria).
 - c. Multiple Shade Operation: Provide hardware as necessary to operate more than one shade using a single motor.
 - d. Radiused Center Support Brackets: Provide brackets and connectors for radiused window applications.
 3. Maximum Offset: 22.5 degrees on each side for a 45-degree total offset.
 4. Maximum Offset: 8 degrees on each side for a 16-degree total offset.
- F. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to five inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- G. Inside Shadebands:
1. Shadeband Material: Light-filtering fabric.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
- H. Outside Shadebands:
1. Shadeband Material: Light-blocking fabric.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
- I. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches .
 2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than as indicated on Drawings.
 3. Endcap Covers: To cover exposed endcaps.
 4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than height indicated on Drawings.
 - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
 5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recesses or pockets and for snap-in attachment to wall clip without fasteners.
 - a. Closure-Panel Width: As indicated on Drawings.
 6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.

7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
8. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.5 INTELLIGENT ENCODED ELECTRONIC DRIVE UNIT (EDU) SYSTEM

- 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. Mechoshade
 2. Or equal.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the following or comparable product:
 1. MechoShade Systems, Inc., [WhisperShade IQ2 System, 120 VAC.]
 2. MechoShade Systems, Inc., [WhisperShade IQ2-DC System, 24 VDC].
- C. Electronic Drive Unit (EDU) System General Requirements:
 1. Provide UL 325 system listed solution.
 - e. Component certification in lieu of system testing is not acceptable.
 2. Listing Label and Motor Rating: Visible for inspection without dismounting of shade assembly to remove motor or EDU from shade roller tube.
 3. Motor Size and Configuration: As recommended by manufacturer for type, size, and arrangement of shades.
 4. Conceal EDU inside shade roller tube.
 5. EDU Rated Speed: The same nominal speed for shades in the same room.
 6. Hanging Weight of Shade Band: Limit to 80 percent of rated lifting capacity of shade EDU and tube assembly.
 7. Capable of upgrading firmware from anywhere on network without touching the motor.
- D. [Motor System: Line Voltage 120 VAC]:
 1. Type: Tubular, asynchronous, integral AC motor and reversible capacitor. 120 VAC, single phase, 60 Hz; temperature Class B, thermally protected, totally enclosed, maintenance-free. Powered by line voltage power supply connection equipped with locking disconnect plug assembly furnished with EDU.
 2. Audible Noise: 46 dBA measured 3 ft (914 mm) from motor unit, depending on motor torque.
 3. Nominal Speed: 34 RPM, without variation based on load/lift capacity.
 4. Isolated, low voltage power supply for powering external accessories connected to either the dry contact or network port.
 - a. Products requiring accessories to be powered by a plug-in or externally supplied power supply are not acceptable.
- E. [Motor System: Low Voltage EDU (24 VDC)]:
 1. Type: Tubular, asynchronous, integral DC motor. 24 VDC; temperature Class B, thermally protected, totally enclosed, maintenance-free. Powered by low voltage power supply connection equipped with disconnect plug assembly furnished with EDU.
 2. Audible Noise: 38 dBA measured 3 ft (914 mm) from motor unit, depending on motor torque.
 3. Nominal Speed: 10 to 28 RPM. Configurable. Speed managed such that it does not vary due to load/lift capacity.
 4. Low voltage power supply for powering external accessories connected to either the dry contact or network port.
 - a. Products that require accessories to be powered by a plug-in or externally supplied power supply are not acceptable.

- F. Control Methods: Local isolated dry contact input.
 - 1. Local Isolated Dry Contact Inputs:
 - a. Local switch control, third party system integration without separate interface.
 - b. Moving EDU/shade to upper and lower limits and local switch preset positions.
 - c. Configuration of upper and lower limits, custom presets, and key modes of operation without a PC or microprocessor-based tools.
 - d. Configuration under protected sequences to prevent changes by casual user.
 - e. Switch Personalities: Configuration of dry contact control port over network such that any type of dry contact keypad/third-party interface and actuation methodology (maintained and/or momentary actuation) can be used to operate shade.
 - f. Dry Contact Control Connection Options to Include:
 - 1) One-button.
 - 2) Two-button.
 - 3) Three-button. Able to support configuring limits, presets, and key operating modes (default).
 - 4) Three-button. No configuration capability to prevent accidental changes in settings.
- G. Alignment Positions:
 - 1. Repeatable and precisely aligned shade positions and limits.
 - a. Support positioning commands from 0 to 100 percent in 1 percent increments.
 - b. Customizable Presets: 32.
 - c. Include three intermediate dry contact presets
 - 2. Shades on same switch circuit or same network group address with same opening height, to align at each intermediate stopping position when traveling from any position, up or down.
 - 3. Shades of differing heights: Capable of custom, aligned intermediate stop positions when traveling from any position, up or down.
 - 4. Alignment of shade bands mechanically aligned on same EDU: Plus, or minus 0.125 inch (3 mm).
 - 5. Alignment of standard shades on adjacent EDUs: Plus, or minus 0.25 inch (6 mm) when commanded to same alignment position.
- H. Local Switch Presets:
 - 1. Minimum of three customizable preset positions accessible over the local dry contact control inputs and over the network connection.
 - 2. Preset positions: Customizable to any position between and including defined upper and lower limits (initially defaults to 25, 50, and 75 percent of shade travel).
 - 3. Configuration of Custom Preset Positions: A handheld removable program module/configurator or a local switch.

2.6 MOTOR CONTROLS, INTERFACES, AND ACCESSORIES

- A. Unless indicated to be excluded, provide required equipment as necessary for a complete operating system providing the control intent specified. Provide components and connections necessary to interface with other systems as indicated.
- B. Low-Voltage Wall Controls; IQ Switch:
 - 1. Momentary dry contact switch enables manual local control or network control of any individual shade motor or shade group/sub-group on MechoNet network.
 - 2. Control Functions:
 - a. Open: Automatically open controlled shades to fully open position when button is pressed.
 - b. Close: Automatically close controlled shades to fully closed position when button is pressed.
 - c. Presets: For selection of predetermined shade positions.

- d. Dual Stations: For individual control of two shades/groups.
3. Finish: White.
4. Single Station: 5-button (open, close, and three intermediate stop positions).
5. Double Station: 10-button (open, close, and three intermediate stop positions for each of two shades/groups).

2.7 SHADEBAND MATERIALS

A. Shadeband Material

1. Flame-Resistance Rating: Comply with NFPA 701 [and SFM Listing as specified]. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Vision Control Light-Filtering Fabric: .

1. Source: Roller shade manufacturer.
2. Series: As indicated on Finish Legend on Drawings.
3. Type: PVC-coated fiberglass PVC-coated polyester Woven PVC-coated fiberglass and PVC-coated polyester Woven polyester and PVC-coated polyester.
4. Weave: Mesh Basketweave.
5. Thickness: <Insert thickness>.
6. Weight: <Insert oz./sq. yd.>.
7. Orientation on Shadeband: Up the bolt Railroaded As indicated on Drawings.
8. Openness Factor: Insert number percent.
9. Color: As indicated on Drawings.

C. Black-out Light-Blocking Fabric.

1. Source: Roller shade manufacturer.
2. Series: As indicated on Finish Legend on Drawings.
3. Type: Fiberglass with acrylic backing.
4. Thickness: <Insert thickness>.
5. Weight: <Insert oz./sq. yd.>.
6. Orientation on Shadeband: Up the bolt Railroaded As indicated on Drawings.
7. Features: Washable.
8. Color: As indicated on Drawings.

2.8 ROLLER SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch . Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch , plus or minus 1/8 inch .
2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
 2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.
 3. Welded Zipper Edge: Full height on both sides of fabric ensuring smooth operation within ShadeLoc channels.

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 123661.16 – SOLID SURFACING COUNTERTOPS

GUIDELINES

1. *Standard is based on North American Architectural Wood Standard (NAAWS) published by Woodwork Institute (WI).*
2. *Consider requiring WI Certified Compliance Program for counters, aligned with requirements in architectural woodwork for casework.*
3. *In order to establish desired quality level, materials and fabrication exceed WI NAAWS specified Custom grade requirements in some cases.*
4. *Consider requiring special procedures for temperature and relative humidity control procedures and systems as required to protect and properly install paneling and millwork, based on specific site location, microclimate conditions, time of year, temperature and relative humidity of specific area. Adjust procedures as required to reflect changed environmental conditions.*

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid Surfacing countertops, non-lab application.
 - a. Solid Surfacing splashes.
 - b. Solid Surface apron fronts and fabrications.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified:
1. Adhesives, sealants, sealers, and adhesives: Comply with SCAQMD VOC content and VOC emissions regulations.
- B. Grade :
1. Grade: Comply with Standard grade, including performance and engineering criteria.
 2. Provide Food Contact:
 - a. Comply with United States Food and Drug Administration (FDA) compliance for food contact materials described in 21 CFR 174 to 21 CFR 190.
 - b. Comply with ANSI NSF 51 food zone contact.
- C. Fire/Life Safety/Habitability:
- a. UL GREENGUARD® Gold Certified product for low-chemical emissions.
 - b. Flame Spread: Maximum 25 per ASTM E 84, 1 /2 inch thickness.
- D. Smoke Contributed: Maximum 25 per ATM E 84, 1 /2 inch thickness. Structural Performance for cantilevered countertops:
1. Loading Criteria:
 - a. 300 lb. vertical gravity loading applied over an area 18 inch by 18-inch square at any part of the casework horizontal surface to create maximum stress and deflection condition.

2. Performance Deflection Criteria:
 - a. No greater than 1 /8-inch vertical deflection perpendicular to the horizontal plane of the casework as noted in loading criteria.
3. Connection Criteria:
 - a. Provide calculations for all embeds and backing required to accommodate cantilever casework frame.

2.2 SOLID SURFACING COUNTERTOPS, GENERAL

- A. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of solid surfacing countertops.
- B. Quality Standard: Unless otherwise indicated, comply with the "North American Architectural Woodwork Standard" (NAAWS) jointly published by WI and AWMAC for grades of architectural woodwork indicated for construction, finishes, installation, and other requirements.
 1. Provide labels and certificates from WI certification program indicating that woodwork, including installation, complies with requirements of grades specified.
 2. Quality Standard: Comply with NAAWS Section 11 requirements for countertops.
 3. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

2.3 SOLID SURFACING COUNTERTOP MATERIALS -

- A. Solid Surfacing: Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1 and ISFA.
 1. Manufacturers:
 - a. Wilsonart.
 - b. E. I. du Pont de Nemours and Company.
 - c. LG Chemical, Ltd.
 - d. Formica
 - e. Or Equal
- B. Colors and Patterns: As indicated by manufacturer's designations in Finish Legend.
- C. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the 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.
- D. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.4 FABRICATION

- A. Fabricate countertops according to solid surfacing manufacturer's written instructions and the NAAWS.
 1. Grade: Custom.
 2. Quality Standard: Comply with NAAWS Section 11 requirements for countertops.
- B. Configuration:
 1. Front: 3/4-inch bullnose Radius edge with apron, 2 inches high with 3/8-inch radius.
 2. Backsplash: Radius edge with 3/8-inch radius.
 3. End Splash: Matching backsplash.

SOLID SURFACING COUNTERTOPS

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- C. Countertops: 3/4-inch thick
- D. Backsplashes: 1/2-inch thick .
- E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surfacing manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
- F. Joints:
 - 1. Fabricate countertops without joints wherever possible. Where configuration requires fabrication in sections for joining in the field, provide joints at locations indicated and as follows:
 - a. Joint Type, Bonded: 1/32 inch or less in width.
 - b. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
- G. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
 - b. Provide vertical edges, rounded to 3/8-inch radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch into fixture opening.
 - c. Provide 3/4-inch full bullnose edges projecting 3/8 inch into fixture opening.
 - 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
 - 4. Counter-Mounted Cooktops: Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

2.5 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surfacing manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION – NOT USED

END OF SECTION 123661.16

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SECTION 124813 ENTRANCE FLOOR MATS AND FRAMES

GUIDELINES

1. *Recessed entrance mat assembly with roll up mat specified for cleaning.*
2. *Mat installation requires close tolerances for level and smooth, tolerance typically not achieved by concrete installation. Pour recess with sufficient depth to permit floating a high strength fill as the final surface.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Roll-up rail mats at entrance locations indicated on drawings.
 2. Recessed frame in slab depression.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide roll-up rail mats and frames capable of withstanding the following loads and stresses within limits and under conditions indicated:
 1. Uniform floor load of 300 lbf. /sq. ft.
 2. Wheel load of 350 lb per wheel.
- B. Accessibility Standard: Comply with applicable provisions in the DOJ's "ADA Standards for Accessible Design" and California Building Code.

2.2 ROLL-UP RAIL MATS – <insert designation>

- 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. Balco; a CSW Industrials Company.
 2. C/S Group.
 3. Mats Inc
 4. Or approved equal.
- B. Roll-up, Aluminum-Rail Hinged Mats: Extruded-aluminum tread rails 1-1/2 inches wide by 3/8 inch thick, sitting on continuous vinyl cushions.
 1. Tread Inserts: Provide one of the following as directed by the State:
 - a. Ribbed-design-surface, resilient vinyl
 - b. Mineral abrasive particles bonded to or embedded in vinyl
 - c. 1/4-inch-high, 28-oz./sq. yd. weight, level-cut, nylon-pile, fusion-bonded carpet.
 2. Rail Color: Provide one of the following as directed by the State:
 - a. Mill finish
 - b. Medium bronze
 - c. Black
 3. Hinges: Aluminum. Perforate as required for drainage.

2.3 FRAMES

A. Recessed Frames: Manufacturer's standard extrusion.

1. Extruded Aluminum: ASTM B221, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.
 - a. Color: Mill.

2.4 CONCRETE FILL AND GROUT MATERIALS

- ### A.
- Provide concrete fill and grout equivalent in strength to cast-in-place concrete slabs for recessed mats and frames. Use aggregate no larger than one-third fill thickness.

2.5 FABRICATION

- ### A.
- Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.
- ### B.
- Recessed Frames: As indicated, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.
1. Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.
- ### C.
- Coat concealed surfaces of aluminum frames that contact cementitious material with manufacturer's standard protective coating.

2.6 ALUMINUM FINISHES

- ### A.
- Mill finish.

PART 3 - EXECUTION – NOT USED

END OF SECTION 124813

SECTION 142110 - ELEVATORS – MRL SYSTEM

GUIDELINES

1. *Review soils report for subsurface rock and water conditions affecting pit construction.*
2. *Confirm controller location and proximity to elevator with manufacturer. California Title 8 does not allow controller located within elevator jamb frame.*
3. *Confirm District direction regarding use of maintenance contracts.*
4. *Confirm approach to non-proprietary elevator control diagnostic and service systems with District and prospective manufacturers.*

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Passenger and service elevators, MRL (machine room less) type.
2. Compliance with seismic provisions required by ASME A17.1, California Code of Regulations, Title 8 and California Building Code, Title 24.
3. Deferred approval/Design Build engineering of guide rail assembly as required by local Agency Having Jurisdiction (DSA).
4. Provide microprocessor-based control systems with diagnostic and adjusting capability.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Kone (Basis of Design)
 2. Otis.
 3. Thyssen Elevator
 4. Schindler
 5. Or equal

2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
1. Contractor shall be responsible for obtaining, in a timely manner, all permits required by Labor Code section 7301.1, CBC Title 24 and CCR Title 8.
 2. Comply with California Code of Regulations, Titles 8, 19, and 24, including accessibility provisions of Title 24, CBC, Chapter 11B and Chapter 30.
 3. In the event of conflict, the more-stringent Code requirements shall apply.
- B. All of the work required to be provided as described in this section of the specifications shall be provided by a single entity sub-contractor skilled in this specialty, holding a valid C-11 California contractor's license.
- C. Accessibility Requirements: Comply with 2010 ADA Standards for Accessible Design and with Title 24, CCR, including Chapter 11B and Chapter 30.

- D. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7, as modified by Chapter 16A, California Building Code.
1. The term "withstand" means "the system 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. Comply with seismic loading provisions as shown on structural drawings.
 3. Seismic Risk Zone: Project is located in Zone 4.
 4. Manufacturer: Responsible for design and engineering of guide rail bracket anchorage to structural system to meet specified requirements.
 5. Design and engineering shall be stamped by a professional structural engineer licensed in California. Provide engineered, stamped and signed calculations for guide rail bracket attachment conditions, as required by local DSA for approval.
- E. Acoustic Criteria:
1. Noise from Elevator Hoist Machine: Not to exceed 55 dBA at a distance of 1 meter from the center line of the motor in a free-field environment.
 2. Noise from Controller: Not to exceed 55 dBA at a distance of 1 meter from the center line of the motor in a free-field environment.
 3. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
 4. Install all vibration isolators in accordance with manufacturer's recommendations.
 5. Install flexible electrical conduit complying with electrical code to hoist machine and controller. In the event that there is occupied space directly adjacent to the motor, route conduit so that it does not penetrate the partition separating the motor from the occupied area.
 6. Carefully align guide rails so that there is minimum impulse generated at guide rail joints with car and counterweight movement during operation.
- F. Non-Proprietary Information
1. Close out submittal Maintenance Manuals shall provide necessary information to order parts for all equipment. All information must be submitted to the Owner within 30 days prior to the acceptance of the elevator installation.
 2. Acceptance will be delayed until all specified information is received, reviewed and approved by the Owner. The information shall include, but not limited to the following:
 - a. The diagnostic means, which shall be the property of the Owner, may be a hand held "smart" tool. If a hand-held tool is provided, it shall be programmed for the specified elevator system only. If periodic reprogramming of the tool is required, this service shall be provided by the Elevator Company, at no additional cost to the Owner, for the lifetime of the equipment.
 - b. Complete wiring diagrams of "as-installed" elevator circuits with index of location and function of all components.
 - c. Complete lubricating instructions and frequency charts, including recommended grade of lubricants.
- G. Demonstration And Training
1. Engage a factory-authorized service representative to train Owner's maintenance personnel in the operation of the controls, systems, cars including emergency adjustments and general maintenance. Demonstration and training shall be on site for a duration of a minimum of 6 hours.
 2. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

H. Maintenance Service

1. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - a. Perform maintenance during normal working hours.
 - b. Perform emergency callback service during normal working hours with response time of two hours or less.

2.3 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.

1. All elevators provided shall accommodate wheelchair access in compliance with CBC Chapter 11B.

B. Elevator Description: PASSENGER

1. Type: MRL, AC Gearless traction elevator.
2. Manufacturer and Series: Kone MonoSpace 300 DX.
3. Rated Load: 3,500 lb
4. Rated Speed: 150 fpm .
5. Operation System: Duplex Group
6. Machine Location: Inside hoistway, mounted on guiderails
7. Controller Location: Remote location inside secured closet and control room.
8. Auxiliary Operations:
 - a. Provide battery-powered lowering function returning car to the main landing irrespective of load.
 - b. Independent service for service elevator.
9. Security Features: Card-reader operation.
10. Car Enclosures
 - a. Inside Width: Dimensions as shown on drawings from side wall to side wall.
 - b. Inside Depth: Dimensions as shown on drawings from back wall to front wall (return panels).
 - c. Inside Height: Dimensions as shown on drawings to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
 - e. Car Fixtures: Satin stainless steel, No. 4 finish.
 - f. Side and Rear Wall Panels: Textured stainless steel.
 - g. Reveals: Black.
 - h. Door Faces (Interior): Textured stainless steel, No. 4 finish.
 - i. Door Sills: Aluminum, mill finish.
 - j. Ceiling: stainless steel, No. 4 finish.
 - k. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at both sides of car.
 - l. Floor prepared to receive flooring as indicated on Finish Legend.
 - 1) Flooring Weight: Allow 5 PSF. Confirm with final material selection.
11. Hoistway Entrances:
 - a. Width: 42 inches.
 - b. Height: 84 inches.
 - c. Type: Two-speed, side sliding.
 - d. Frames: Satin stainless steel, No. 4 finish.

- e. Frames at Other Floors: Satin stainless steel, No. 4 finish.
 - f. Doors: Textured stainless steel.
 - g. Doors at Other Floors: Textured stainless steel.
 - h. Sills: Aluminum.
 - i. Sills at Other Floors: Aluminum.
12. Star of Life Symbol: Identify emergency elevators with star of life symbol per CBC 3002.4.6a, not less than 3 inches high, on both inside surfaces of hoistway door frames, not less than 78 inch or more than 84 inches.
13. Hall Fixtures: Satin stainless steel, No. 4 finish.
14. Additional Requirements:
- a. Provide inspection certificate in each car, mounted under acrylic cover with stainless steel frame.
 - b. Provide hooks for protective pads in all cars and one complete set of full-height protective pads.

2.4 SYSTEMS AND COMPONENTS

- A. Machine: AC gearless machine, with permanent magnet synchronous motor, direct current electro-mechanical disc brakes and integral traction drive sheave, mounted to the car guide rail at the top of the hoistway.
- B. Governor: Friction type over-speed governor rated for the duty of the elevator specified.
- C. Buffers, Car and Counterweight: Polyurethane buffer.
- D. Hoistway Operating Devices:
 - 1. Emergency stop switch in the pit
 - 2. Terminal stopping switches.
 - 3. Emergency stop switch on the machine
- E. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- F. Car Frame and Platform: Welded steel units.
- G. Guides: Roller guides; polymer-coated, nonlubricated sliding guides; or sliding guides with guide-rail lubricators. Provide guides at top and bottom of car and counterweight frames.
- H. Elevator systems vibration isolation:
 - 1. Hoist Machine – Mount in proper alignment using material as specified by manufacturer and suitable to achieve specified vibration and noise criteria.

2.5 OPERATION SYSTEMS

- A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.
- B. Provide MCE or equal microprocessor-based control systems with diagnostic and adjusting capability not requiring elevator manufacturer company equipment, diagnostic tools or programming.
 - 1. Elevator control system shall not require any external Proprietary service tool.
 - 2. Elevator control system shall be serviceable and maintainable by any qualified elevator maintenance provider capable of maintaining apparatus of similar design and complexity.

- C. Leveling Function: Provide automatic, self-leveling feature that automatically brings the car to the floor landings within a tolerance of plus or minus 1/2 inch under normal loading and unloading conditions.
 - 1. The clearance between the car platform sill and the edge of the hoistway landing shall comply with applicable code.
- D. Program door operating sequence to comply with specified door open/floor wait criteria. Provide independently adjustable door open times.
 - 1. Program doors to remain open for minimum 5 seconds on arrival at floor in response to car-initiated selection in compliance with CBC 11B-407.3.4.
- E. Program hall call notification time in compliance with CBC 11B-407.3.4, with a minimum of 5 seconds to start of close function.
 - 1. Program doors to remain open for minimum 5 seconds on arrival at floor in response to car-initiated selection in compliance with CBC 11B-407.3.5.
- F. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
 - 1. Single-Car Battery-Powered Lowering: When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery.
- G. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.
 - 1. Provision for surface mounted card reader.

2.6 DOOR REOPENING DEVICES

- A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen in accordance with CBC 11B-407.3.3.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

- A. General: Provide car enclosures to receive wall panels, with removable escape hatch, power door operators, and exhaust fan.
 - 1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
 - 1. Subfloor: Coordinate with work provided by others for underlayment thickness and weight
 - 2. Fabricate car with recesses and cutouts for signal equipment.
 - 3. Fabricate car door frame integrally with front wall of car.
 - 4. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
 - 5. Sight Guards: Provide sight guards on car doors.
 - 6. Sills: Extruded metal, with grooved surface, 1/4 inch 6.4 mm thick.

2.8 HOISTWAY ENTRANCES

- A. Fire-Rated Hoistway Entrance Assemblies: Door-and-frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252 or UL 10B.
 - 1. Fire-Protection Rating: 1-1/2 hours.
- B. Hoistway jamb marking:
 - 1. Floor Designation: Provide the floor number on which the jamb is located designated by raised characters, minimum 2 inches high, conforming to Section 11B-407.2.3 and Grade 2 Braille conforming to Section 11B-407.2.3. Locate designation 60 inches on center above the floor on the jamb panels on both sides of the door so that they are visible from within the elevator.
 - 2. Grade Level: Provide a raised five-pointed star shall be placed to the left of the raised character, minimum outside diameter of the star shall be 2 inches. Braille shall be placed below the corresponding raised characters.
 - 3. Star of Life Symbol: Identify emergency elevators with star of life symbol per CBC 3002.4.6.a, , not less than 3 inches, on both inside surfaces of hoistway door frames, not less than 78 inch or more than 84 inches above floor level.
 - 4. Permanently applied plates are acceptable if they are permanently fixed to the jambs
 - 5. Color: Provide white raised characters and symbols on a black background.
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
 - 1. Stainless-Steel Frames: Formed from stainless-steel sheet.
 - 2. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
 - 3. Sight Guards: Provide sight guards on doors matching door edges.
 - 4. Sills: Extruded metal, with grooved surface, 1/4 inch 6.4 mm thick.
 - 5. Non-shrink, Nonmetallic Grout: Provided as work specified in other sections.

2.9 SIGNAL EQUIPMENT

- A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with LEDs.
- B. Car-Control Stations: Provide manufacturer's standard recessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
 - 1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille in compliance with CBC Section 11B-407.4.6, including:
 - a. Dimension: Minimum dimension of 3/4-inch diameter, raised 1/8 inch plus or minus 1/32 inch above the surrounding surface.
 - b. Illumination: Provide illuminated control buttons,
 - c. Configuration: Provide buttons with square shoulders, activated by a mechanical motion that is detectable.
 - d. Tactile and Braille Criteria: At all control buttons, provide 5/8-inch minimum raised characters and standard raised symbols conforming to CBC Section 11B-407.4.6. Locate Grade 2 Braille immediately below the character or symbol. Provide a minimum clear space of 3/8 inch or other suitable means of separation between rows of control buttons.
 - e. Controls and emergency equipment identified by raised symbols shall include, but not be limited to, "door open," "door close," "alarm bell," "emergency stop and "telephone." Designate the call button for the main entry floor by a raised star at the left of the floor designation.
 - f. Color: Provide white raised characters and symbols on a black background.

ELEVATORS – MRL SYSTEM

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2. Locate centerline of elevator floor buttons no higher than 48 inches above the finish floor. Group emergency controls, including the emergency stop and alarm, in or adjacent to the bottom of panel and no lower than 2 feet 11 inches from the floor.
 3. Provide floor buttons with visual indicators to show when each call is registered. The visual indicators shall be extinguished when each call is answered.
- C. Firefighters' Two-Way Telephone Communication Service: Provide telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Section 284621.11 "Addressable Fire-Alarm Systems." Car.
- D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
1. Locate all controls and signage within 48 inches of floor.
 2. Provide signage identifying phone enclosure and instructions for use in raised tactile and braille format complying with CBC Section 11B-407.4.9.
 3. Integrate and connect voice communication system to monitoring station and building telephone system.
- E. Emergency Communication System for Deaf, Hard of Hearing, and Speech Impaired: Manufacturer's standard design, complying with CBC Section 3001.2, and providing the following capabilities:
1. Continuous, 24/7 monitoring providing video based allowing emergency personnel to establish communications with persons in each elevator cab.
 - a. Emergency Personnel Communication shall override any existing connection outside of building.
 - b. Provide light that illuminates and flashes when call is acknowledged.
 - c. On the same car operating panel as the phone push button, provide capability to communicate with and obtain responses from passengers.
 - d. Provide display video capability for entrapment assessment.
 2. Fully accessible to the deaf, hard of hearing and speech impaired, providing capability to communicate visually with and obtain responses from passengers.
 3. Voice- only options for hearing individuals.
 4. Communication using video conferencing technology, chat/text software or other approved technology.
 5. Provide controls meeting accessible reach ranges per CBC Chapter 11B.
 6. Provide instructions for use and battery backup power supply.
- F. Car Position Indicator: Comply with CBC Section 11B-407.4.8. Provide illuminated, digital-type car position indicator, minimum 1 1/2-inch-high, located above car door or above car-control station. Provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.
- G. Hall Push-Button Stations: Provide minimum one hall push-button station at each landing.
1. Provide manufacturer's units with flat faceplate for mounting with body of unit recessed in wall.
 2. Location: 42 inches above the floor to centerline of highest hall call buttons.
 3. Size: Per CBC 11B-407.2.1.2, provide minimum of 3/4 inch diameter buttons, raised 1/8 inch, plus or minus 1/32 inch above the surrounding surface. Locate button designating the up direction on top.
 4. Provide visual indication to show each call registered and extinguished when answered.
 5. Objects adjacent to, and below, hall call buttons shall not project more than 4 inches from the wall.
 6. Illumination: Per CBC 11B-407.2.1.5, illuminate button with a white light over the entire surface of the button.

7. Provide telephone jack in each unit for firefighters' two-way telephone communication service.
 - H. Hall Lanterns: Units with illuminated arrows with a single arrow at terminal landings. Provide the following:
 1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
 2. Size: Minimum of 2-1 /2 inches high by 2-1 /2 inches wide and visible from the proximity of the hall call button.
 - I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
 1. At manufacturer's option, audible signals may be placed on cars.
 - J. Hall Position Indicators: Provide illuminated digital-display-type position indicators, located above hoistway entrance at ground floor. Provide units with flat faceplate for mounting and with body of unit recessed in wall.
 - K. Car and Landing Illumination: Provide minimum 5-foot candles illumination at the car controls threshold and the landing when the car and landing doors are open.
 - L. Emergency Pictorial Signs: Fabricate from Lexan materials, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.
- 2.10 FINISH MATERIALS
- A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
 - B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
 - C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
 - D. Textured Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, with embossed texture rolled into exposed surface.
 1. Product: Subject to compliance with requirements, provide "Rigidized Series 4LB.
 - E. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 441.
 1. Provide Type 441 at elevator entrance frames.
 - F. Stainless-Steel Bars: ASTM A 276, Type 441.
 - G. Stainless-Steel Tubing: ASTM A 554, Grade MT 441.
 - H. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.

PART 3 - EXECUTION – NOT USED

END OF SECTION 142110

SECTION 142400 - HYDRAULIC ELEVATORS

GUIDELINES

1. *Review soils report for subsurface rock and water conditions.*
2. *Verify jack configuration by manufacturer and stop count. Not all manufacturers provide telescoping jack systems above two floors.*
3. *Confirm "machine" room / controller location and proximity to elevator with manufacturer.*
4. *Confirm District direction regarding use of maintenance contracts.*
5. *Confirm approach to non-proprietary elevator control diagnostic and service systems with District and prospective manufacturers.*

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
1. Hydraulic passenger and service elevators.
 2. Compliance with seismic provisions required by ASME A17.1, California Code of Regulations, Title 8 and California Building Code, Title 24.
 3. Deferred approval/Design Build engineering of guide rail assembly as required by local Agency Having Jurisdiction (AHJ).

PART 2 - PRODUCTS

2.1 HYDRAULIC ELEVATOR MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
1. Otis Elevator Co.
 2. Schindler Elevator Corp.
 3. ThyssenKrupp Elevator.
- C. Source Limitations: Obtain elevators [including freight and electric traction passenger elevators specified in other Division 14 Sections for other elevator types] from single manufacturer.
1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
1. Contractor shall be responsible for obtaining, in a timely manner, all permits required by Labor Code section 7301.1, CBC Title 24 and CCR Title 8.
 2. Comply with California Code of Regulations, Titles 8, 19, and 24, including accessibility provisions of Title 24, CBC, Chapter 11B and Chapter 30.

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3. In the event of conflict, the more-stringent Code requirements shall apply.
- B. All of the work required to be provided as described in this section of the specifications shall be provided by a single entity sub-contractor skilled in this specialty, holding a valid C-11 California contractor's license.
- C. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with CBC Chapter 11B and Chapter 30.
- D. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 as modified by CBC Chapter 16A and shall comply with elevator seismic requirements in ASME A17.1/CSA B44.
 1. The term "withstand" means "the system 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. Provide earthquake equipment required by ASME A17.1/CSA B44.
 3. Provide seismic switch required by ASCE/SEI 7.
 4. Design earthquake spectral response acceleration short period (Sds) for Project is **<Insert value>**.
 5. Project's Seismic Design Category: **[C] [D] [E] [F]**.
 6. Elevator Component Importance Factor: **[1.5] [1.0]**.

2.3 ELEVATORS

- A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.
- B. Elevator Description:
 1. Passenger Elevator Number(s): **<Insert elevator number(s) as shown on Drawings>**.
 2. Type: Holeless, beside-the-car, telescoping, dual cylinder.
 3. Rated Load: 3500 lb.
 4. Rated Speed: 200 fpm.
 5. Operation System: Selective-collective automatic operation.
 6. Security Features: Card-reader operation.
 7. Car Enclosures:
 - a. Inside Width: Insert dimension from side wall to side wall.
 - b. Inside Depth: Insert dimension from back wall to front wall (return panels).
 - c. Inside Height: Not less than [93 inches] **<Insert dimension>** to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
 - e. Car Fixtures: Satin stainless steel, No. 4 finish.
 - f. Side and Rear Wall Panels: Textured stainless steel.
 - g. Reveals: Satin stainless steel, No. 4 finish.
 - h. Door Faces (Interior): Textured stainless steel.
 - i. Door Sills: Aluminum.
 - j. Ceiling: Satin stainless steel, No. 4 finish.
 - k. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at sides and rear of car.
 - l. Floor prepared to receive carpet (specified in Division 09 Section "Sheet Carpeting").
 - m. Floor prepared to receive resilient flooring (specified in Division 09 Section "Resilient Flooring").

HYDRAULIC ELEVATORS

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- n. Floor recessed and prepared to receive [dimension stone][tile] specified in Division 09 Section " Tiling"]
 - o. Floor Thickness, Including Setting Materials: <Insert thickness> above plywood subfloor.
- 8. Hoist way Entrances:
 - a. Width: 36 inches.
 - b. Height: [84 inches] <Insert dimension>.
 - c. Type: Two-speed side sliding.
 - d. Frames : Satin stainless steel, No. 4 finish.
 - e. Frames at Other Floors: Satin stainless steel, No. 4 finish.
 - f. Doors: Textured stainless steel.
 - g. Doors at Other Floors: Textured stainless steel.
 - h. Sills : Aluminum.
 - i. Sills at Other Floors: Aluminum.
- 9. Hall Fixtures : Satin stainless steel, No. 4 finish.
- 10. Hall Fixtures at Other Floors: Satin stainless steel, No. 4 finish.
- C. Hoist way jamb marking:
 - 1. Floor Designation: Provide the floor number on which the jamb is located designated by raised characters, minimum 2 inches high, conforming to Section 11B-407.2.3 and Grade 2 Braille conforming to Section 11B-407.2.3. Locate designation 60 inches on center above the floor on the jamb panels on both sides of the door so that they are visible from within the elevator.
 - 2. Grade Level: Provide a raised five-pointed star shall be placed to the left of the raised character, minimum outside diameter of the star shall be 2 inches. Braille shall be placed below the corresponding raised characters.
 - 3. Star of Life Symbol: Identify emergency elevators with star of life symbol per CBC 3002.4.6.a, not less than 3 inches high, on both inside surfaces of hoist way door frames, not less than 78 inch or more than 84 inches above floor level.
 - 4. Permanently applied plates are acceptable if they are permanently fixed to the jambs
 - 5. Color: Provide white raised characters and symbols on a black background.
- D. Electrical Requirements and Operations
 - 1. Voltage: 480 208 Volts, 3 phase
 - 2. HP: Maximum <Obtain requirements from Project electrical engineer>
 - 3. Minimum Power Factor: 0.8
 - 4. Fuse Protection: Selected for application by supplier
 - 5. Wiring: Provide wiring from control panels and relay panels to equipment and from hoist way junction box to elevator. Provide transformer for required relay panel control voltage. Install all wiring in metal wireways, galvanized steel and liquid-tight flexible raceways as specified in Division 26 Section "Raceways", except for traveling cables.
 - a. Branch Circuit and Control Wiring: TEW or THW insulation, 600 volts.
 - b. Signal and Communication Wiring: Meet system manufacturers requirements. Provide wiring in machine room for system interconnection to hoist way junction box. Extend from hoist way junction box to cab with traveling cables.
 - c. Traveling Cables: UL labeled fire and moisture resistant with outer braid and steel supporting strand. Provide cables for all systems links to cab with minimum 10 percent spares for each cable type.

2.4 SYSTEMS AND COMPONENTS

- A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.
 - 1. Pump shall be [submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts] [or] [shall be tank-top-mounted type with fan-cooled, squirrel-cage induction motor, and shall be mounted on oil tank with vibration isolation mounts and enclosed in prime-painted steel enclosure lined with 1-inch- thick, glass-fiber insulation board].
 - 2. Motor shall have [wye-delta] [or] [solid-state] starting.
 - 3. Motor shall have variable-voltage, variable-frequency control.
- B. Hydraulic Silencers: System shall have hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.
- C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.
 - 1. Cylinder units shall be connected with dielectric couplings.
 - 2. Casing for Underground Piping: Schedule 40 PVC pipe complying with ASTM D 1785, joined with PVC fittings complying with ASTM D 2466 and solvent cement complying with ASTM D 2564.
- D. Hydraulic Fluid: Nontoxic, biodegradable, fire-resistant fluid, made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives, that is approved by elevator manufacturer for use with elevator equipment.
 - 1. Product: Subject to compliance with requirements, provide "Hydro Safe" by Hydro Safe Oil Division, Inc.
- E. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- F. Car Frame and Platform: Welded [or bolted] steel units.
- G. Guides: Roller guides. Provide guides at top and bottom of car frame.
- H. Electrical Requirements: Variable-voltage, variable-frequency, ac-type machines [or variable-voltage dc-type machines] and solid-state power converters.
 - 1. Provide regenerative system. Do not allow regenerative power to be reflected back into building electrical distribution system.
 - 2. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
 - 3. Provide means for absorbing regenerated power when elevator system is operating on standby power.
 - 4. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.

2.5 OPERATION SYSTEMS

- A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.
- B. Provide MCE or equal microprocessor-based control systems with diagnostic and adjusting capability not requiring elevator manufacturer company equipment, diagnostic tools or programming.
 - 1. Elevator control system shall not require any external Proprietary service tool.

2. Elevator control system shall be serviceable and maintainable by any qualified elevator maintenance provider capable of maintaining apparatus of similar design and complexity.
- C. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
1. Single-Car Standby-Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at . Manual operation causes automatic operation to cease.
 2. Single-Car Battery-Powered Lowering: When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
 3. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors start closing.
 4. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
 5. Independent Service: Key switch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from key switch when car is in independent service. When in independent service, doors close only in response to door close button.
 6. Service: Service is initiated by a key switch card reader at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks. Car is placed in operation by selecting a floor and pressing door close button or by operating key switch to put car in independent service. After responding to floor selected or being removed from independent service, car returns to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.
 7. Emergency Firefighter's Service: Comply with requirements of ASME A17.1/CSA B44, state and local building codes, and requirements of authorities having jurisdiction, including the following requirements unless superseded by code requirements:
 - a. Fire Alarm Elevator Recall Operation: On activation of fire alarm system signal, car returned to designated floor and parked with doors open. Provide primary and secondary designated floor for each car. Configure such that firefighters key required to manually put car in service.
 - b. Fire Alarm Elevator Recall Operation: On activation of fire alarm system signal, cars returned to designated floor and parked with doors open. Provide primary and secondary designated floor for each car. Configure such that one car at a time returned with priority given to loaded cars. Configure such that firefighters key required to manually put cars in service.
 8. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after 5 minutes and are re-energized before car doors open.
- D. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.
1. Card-Reader Operation: System uses card readers at car-control stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space for card reader in car.
 - a. Security access system equipment is [specified in Section 281500 "Access Control Hardware Devices."] [not in the Contract.]

2. Key switch Operation: Push buttons are activated and deactivated by security key switches at car-control stations hall push-button stations. Key is removable. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers.
 3. Video Surveillance Operation: For elevator cab monitoring, provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other access system equipment, and elevator controllers.
- E. Leveling Function: Provide automatic, self-leveling feature that automatically brings the car to the floor landings within a tolerance of plus or minus 1/2 inch under normal loading and unloading conditions.
1. The clearance between the car platform sill and the edge of the hoist way landing shall be no greater than 1-1/4 inches.
- F. Program door operating sequence to comply with specified door open/floor wait criteria. Provide independently adjustable door open times.
1. Program doors to remain open for a minimum 5 seconds on arrival at floor in response to car-initiated selection in compliance with CBC 11B-407.3.4.
- G. Program hall call notification time in compliance with CBC 11B-407.3.4, with a minimum of 5 seconds to start of close function.
1. Program doors to remain open for a minimum of 5 seconds on arrival at floor in response to car initiated selection in compliance with CBC 11B-407.3.5.
- 2.6 DOOR-REOPENING DEVICES
- A. Infrared Array: Provide door-reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door-reopening device, a loud buzzer shall sound, and doors shall begin to close at reduced kinetic energy.
- 2.7 CAR ENCLOSURES
- A. General: Provide enclosures to receive removable [steel-framed car enclosures with nonremovable] wall panels, with [removable] car roof, access doors, power door operators, and ventilation.
1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
1. Subfloor: Exterior, underlayment-grade plywood, not less than 5/8-inch nominal thickness.
 2. Floor Finish: Specified in <Insert Section number and title>.
 3. Stainless-Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless-steel sheet.
 4. Fabricate car with recesses and cutouts for signal equipment.
 5. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
 6. Sight Guards: Provide sight guards on car doors.
 7. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
 8. Metal Ceiling: Flush panels, with each panel. Handrails: Shape, metal, and finish indicated.
 9. Light Fixture Efficiency: Not less than 35 lumens/W.
 10. Ventilation Fan Efficiency: Not less than 3.0 cfm/W.

2.8 HOISTWAY ENTRANCES

- A. Fire-Rated Hoist way Entrance Assemblies: Door-and-frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252 or UL 10B.
 - 1. Fire-Protection Rating: 1-1/2 hours.
- B. Materials and Fabrication: Manufacturer's standards, but not less than the following:
 - 1. Stainless-Steel Frames: Formed from stainless-steel sheet.
 - 2. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than 3 inches high, on both jambs of hoist way door frames.
 - 3. Stainless-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from stainless-steel sheet.

2.9 SIGNAL EQUIPMENT

- A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide vandal-resistant] buttons and lighted elements illuminated with LEDs.
- B. Car-Control Stations: Provide manufacturer's standard semi recessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
 - 1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille in compliance with CBC Section 11B-407.4.6, including:
 - a. Dimension: Minimum dimension of 3/4-inch diameter, raised 1/8 inch plus or minus 1/32 inch above the surrounding surface.
 - b. Illumination: Provide illuminated control buttons,
 - c. Configuration: Provide buttons with square shoulders, activated by a mechanical motion that is detectable.
 - d. Tactile and Braille Criteria: At all control buttons, provide 5/8-inch minimum raised characters and standard raised symbols conforming to CBC Section 11B-407.4.6. Locate Grade 2 Braille immediately below the character or symbol. Provide a minimum clear space of 3/8 inch or other suitable means of separation between rows of control buttons.
 - e. Controls and emergency equipment identified by raised symbols shall include, but not be limited to, "door open," "door close," "alarm bell," "emergency stop" and "telephone." Designate the call button for the main entry floor by a raised star at the left of the floor designation.
 - f. Color: Provide white raised characters and symbols on a black background.
 - 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
 - 1. Locate all controls and signage within 48 inches of floor.
 - 2. Provide signage identifying phone enclosure and instructions for use in raised tactile and braille format complying with CBC Section 11B-407.4.9.
 - 3. Integrate and connect voice communication system to monitoring station and building telephone system.

- D. Emergency Communication System for Deaf, Hard of Hearing, and Speech Impaired: Manufacturers standard design, complying with CBC Section 3001.2, and providing the following capabilities:
1. Continuous, 24/7 monitoring providing video based allowing emergency personnel to establish communications with persons in each elevator cab.
 - a. Emergency Personnel Communication shall override any existing connection outside of building.
 - b. Provide light that illuminates and flashes when call is acknowledged.
 - c. On the same car operating panel as the phone push button, provide capability to communicate with and obtain responses from passengers.
 - d. Provide display video capability for entrapment assessment.
 2. Fully accessible to the deaf, hard of hearing and speech impaired, providing capability to communicate visually with and obtain responses from passengers.
 3. Voice- only options for hearing individuals.
 4. Communication using video conferencing technology, chat/text software or other approved technology.
 5. Provide controls meeting accessible reach ranges per .
 6. Provide instructions for use and battery backup power supply.
- E. Firefighters' Two-Way Telephone Communication Service: Provide telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section "Fire Alarm Systems." Comply with CBC Section 11B-407.4.8. Device supplied by fire alarm system supplier.
- F. Car Position Indicator: Provide [illuminated,] digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.
- G. Hall Push-Button Stations: Provide minimum one hall push-button station at each landing as indicated.
1. Provide [manufacturer's standard wall-mounted units] [units with flat faceplate for mounting with body of unit recessed in wall] [jamb-mounted units].
 2. Equip units with buttons for calling elevator and for indicating applicable direction of travel.
 3. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in [Section 284621.11 "Addressable Fire-Alarm Systems."] [Section 284621.13 "Conventional Fire-Alarm Systems."]
 4. Location: 42 inches above the floor to centerline of highest hall call buttons.
 5. Size: Per CBC 11B-407.2.1.2, provide minimum of 3/4-inch diameter buttons, raised 1/8 inch, plus or minus 1/32 inch above the surrounding surface. Locate button designating the up direction on top.
 6. Provide visual indication to show each call registered and extinguished when answered.
 7. Objects adjacent to, and below, hall call buttons shall not project more than 4 inches from the wall.
 8. Illumination: Per CBC 11B-407.2.1.5, illuminate button with a white light over the entire surface of the button.
 9. Provide telephone jack in each unit for firefighters' two-way telephone communication service.

- H. Hall Lanterns: Units with illuminated arrows; however, provide single arrow at terminal landings. Provide the following:
 - 1. Manufacturer's standard wall-mounted units, for mounting above entrance frames. [Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing]
 - 2. Size: Minimum of 2-1 /2 inches high by 2-1 /2 inches wide and visible from the proximity of the hall call button.
- I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
 - 1. At manufacturer's option, audible signals may be placed on cars.
- J. Hall Position Indicators: Provide [illuminated,] digital-display-type position indicators, located above [each] hoist way entrance at ground floor.
 - 1. Provide units [with flat faceplate for mounting and with body of unit recessed in wall] [integral with entrance head jamb].
 - 2. Integrate ground-floor hall lanterns with hall position indicators.
- K. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

- A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoist way entrance doors and frames, and signal equipment as indicated.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
- D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- E. Textured Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, with embossed texture rolled into exposed surface.
 - 1. Product: Subject to compliance with requirements, provide "<Insert product name>" by <Insert manufacturer's name>.
 - 2. Metal surface is [satin polished] [satin relieved] [titanium nitride colored] [oxide colored] [satin polished and titanium nitride colored] [satin relieved and titanium nitride colored] [satin polished and oxide colored] [satin relieved and oxide colored] [color coated and satin relieved] [color coated and bright relieved] after texturing.
- F. Stainless-Steel Bars: ASTM A 276, Type 304.
- G. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
- H. Aluminum Extrusions: ASTM B 221, Alloy 6063.
- I. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.
- J. Plastic Laminate: High-pressure type complying with NEMA LD 3, [Type HGS for flat applications] [Type HGL for flat applications].

PART 3 - EXECUTION – NOT USED

END OF SECTION

2.2

Guideline Specifications Volume 2: Div 15-33





PASADENA AREA COMMUNITY COLLEGE DISTRICT

District Standards and Guidelines

CannonDesign Project Number 007459.00

Project Manual Guideline Specifications Version 01

Volume 2 Divisions 21 through 28

August 8, 2025

CANNONDESIGN

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Author Legend

Abbreviation	Firm	Discipline
CD	CannonDesign	Architectural
CD	CannonDesign	Mechanical
CD	CannonDesign	Electrical
CD	CannonDesign	Plumbing
CD	CannonDesign	IT
CD	CannonDesign	Security
		Owner

Issue Legend

Abbreviation	Title	Date
Draft 1	Standards and Guidelines Draft 1	March 24, 2025
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Final	Standards and Guidelines Final	August 08, 2025

Notes:

1. Sections without a date will be included in a future issuance.
2. **Bold section number, title, author, and date** indicates a **revised** or **new** section.
3. Text that is ~~struck-out~~ indicates a deleted section.

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260913	Electric Power Management Systems	CD	08/08/25
260944	Lighting Control System	CD	08/08/25
261230	Medium Voltage Transformers	CD	08/08/25
261300	Medium Voltage Switchgear	CD	08/08/25
262200	Low Voltage Transformer	CD	08/08/25

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262300	Low Voltage Power Switchgear	CD	08/08/25
262413	Switchboards	CD	08/08/25
262416	Panelboards	CD	08/08/25
262726	Wiring Devices	CD	08/08/25
262800	Protective Devices	CD	08/08/25
262913	Motor Controllers	CD	08/08/25
263213	Engine Generator Sets	CD	08/08/25
263600	Transfer Switches	CD	08/08/25
265119	Interior Lighting - LED	CD	08/08/25
265600	Exterior Lighting	CD	08/08/25
	DIVISION 27 - COMMUNICATIONS		
270538	Wire Basket Type Cable Trays	CD	
271000	Structured Telecommunications Cabling Systems	CD	08/08/25
271116	Communications Cabinets and Racks	CD	08/08/25
271123	Cable Runway	CD	08/08/25
274111	Integrated Audio Visual Systems for Conference Rooms	CD	08/08/25
274116	Public Address Systems	CD	08/08/25
275314	GPS Wireless Master Clock System	CD	08/08/25
	DIVISION 28 – ELECTRONIC SAFETY AND SECURITY		
281300	Access Control/Intrusion Detection System	CD	08/08/25
282300	Video Surveillance System Expansion	CD	08/08/25
283100	Fire Alarm and Mass Notification Systems	CD	08/08/25
284800	Emergency Response Systems	CD	08/08/25
	DIVISION 31 – EARTHWORK NOT INCLUDED AT THIS TIME		
	DIVISION 32 – EXTERIOR IMPROVEMENTS - NOT INCLUDED AT THIS TIME		
	DIVISION 33 – UTILITIES NOT INCLUDED AT THIS TIME		

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SECTION 211000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 – GENERAL – NOT USED

PART 2 - PRODUCTS

1.1 SYSTEM DESCRIPTION

- A. Automatic wet-type, **[Class I] [Class II] [Class III]** standpipe system.
- B. Automatic dry-type, **[Class I] [Class II] [Class III]** standpipe system.
- C. Semiautomatic dry-type, **[Class I] [Class II] [Class III]** standpipe system.
- D. Manual wet-type, Class I standpipe system.
- E. Manual dry-type, Class I standpipe system.
- F. Automatic combination wet-type standpipe sprinkler system.
- G. Automatic wet-pipe sprinkler system.
- H. Automatic dry-pipe sprinkler.
- I. Automatic deluge sprinkler system.
- J. Automatic single-interlock preaction sprinkler system.
- K. Automatic double-interlock preaction sprinkler system.

1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-suppression system piping to withstand the effects of earthquake motions determined in accordance with **[NFPA 13] [NFPA 14] [and] [ASCE/SEI 7] <Insert standard>**. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- B. Fire-Suppression System Components, Devices, and Accessories: Listed in UL's "Fire Protection Equipment Directory" and FM Approvals' "Approval Guide."
- 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. Fire-suppression system equipment, specialties, accessories, installation, and testing to comply with **[NFPA 13] [NFPA 13R] [NFPA 14] [NFPA 13D] [and] [ASME A17.1] <Insert standard>**.
- E. Standard-Pressure Piping System Component: Listed for 175 psig 1200 kPa minimum working pressure.
- F. High-Pressure Piping System Component: Listed for **[250 psig 1725 kPa minimum] [300 psig 2070 kPa]** working pressure.
- G. Delegated Design: Engage a **[qualified professional engineer] [NICET Level III-certified technician, "Water-Based Systems Layout"] [NICET Level IV-certified technician, "Water-Based Systems Layout"]** to design fire-suppression systems.
 - 1. Fire-Hydrant Flow Test:
 - a. Available fire-hydrant flow test records indicate the following conditions:
 - 1) Date: **<Insert test date>**.
 - 2) Time: **<Insert time> [a.m.] [p.m.]**
 - 3) Performed by: **<Insert operator's name> of <Insert firm>**.
 - 4) Location of Residual Fire Hydrant R: **<Insert location>**.

- 5) Location of Flow Fire Hydrant F: <Insert location>.
 - 6) Static Pressure at Residual Fire Hydrant R: <Insert psig kPa>.
 - 7) Measured Flow at Flow Fire Hydrant F: <Insert gpm L/s>.
 - 8) Residual Pressure at Residual Fire Hydrant R: <Insert psigkPa>.
 - b. Perform fire-hydrant flow test and record the following conditions:
 - 1) Date: <Insert test date>.
 - 2) Time: <Insert time> [a.m.] [p.m.]
 - 3) Performed by: <Insert operator's name> of <Insert firm>.
 - 4) Location of Residual Fire Hydrant R: <Insert location>.
 - 5) Location of Flow Fire Hydrant F: <Insert location>.
 - 6) Static Pressure at Residual Fire Hydrant R: <Insert psig kPa>.
 - 7) Measured Flow at Flow Fire Hydrant F: <Insert gpm L/s>.
 - 8) Residual Pressure at Residual Fire Hydrant R: <Insert psig kPa>.
 - c. Fire-hydrant flow test must be performed within previous [12] <Insert number> months prior to completion of design documents and hydraulic calculations.
2. Margin of Safety for Available Water Flow and Pressure: [10] [20] <Insert number> percent, including losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications:
 - a. Automobile Parking and Showrooms: [Ordinary Hazard, Group 1] <Insert classification>.
 - b. Churches: [Light Hazard] <Insert classification>.
 - c. Dry Cleaners: [Ordinary Hazard, Group 2] <Insert classification>.
 - d. Educational: [Light Hazard] <Insert classification>.
 - e. Electrical Equipment Rooms: [Ordinary Hazard, Group 1] <Insert classification>.
 - f. Elevator Machine Room and Hoistway: [Ordinary Hazard, Group 1] <Insert classification>.
 - g. Exterior and Interior Loading Docks, Handling Flammable/Combustible Liquids, Hazardous Materials, or Utilized for Storage: <Insert classification>.
 - h. Exterior Loading Docks, Only Handling Ordinary Combustibles: [Ordinary Hazard, Group 2] <Insert classification>.
 - i. General Storage Areas: [Ordinary Hazard, Group 1] <Insert classification>.
 - j. Hospitals, including Animal Hospitals and Veterinary Facilities: [Light Hazard] <Insert classification>.
 - k. Institutional: [Light Hazard] <Insert classification>.
 - l. Laundries: [Ordinary Hazard, Group 1] <Insert classification>.
 - m. Libraries, except Large Stack Rooms: [Light Hazard] <Insert classification>.
 - n. Libraries, Large Stack Rooms: [Ordinary Hazard, Group 2] <Insert classification>.
 - o. Machine Shops: [Ordinary Hazard, Group 2] <Insert classification>.
 - p. Mechanical Equipment Rooms: [Ordinary Hazard, Group 1] <Insert classification>.
 - q. Mercantile: [Ordinary Hazard, Group 2] <Insert classification>.
 - r. Museums: [Light Hazard] <Insert classification>.
 - s. Nursing or Convalescent Homes: [Light Hazard] <Insert classification>.
 - t. Offices, including Data Processing: [Light Hazard] <Insert classification>.
 - u. Plastics Processing Areas: [Extra Hazard, Group 2] <Insert classification>.
 - v. Post Offices: [Ordinary Hazard, Group 2] <Insert classification>.
 - w. Printing Plants: [Extra Hazard, Group 1] <Insert classification>.
 - x. Printing and Publishing: [Ordinary Hazard, Group 2] <Insert classification>.
 - y. Repair Garages: [Ordinary Hazard, Group 2] <Insert classification>.
 - z. Residential: [Light Hazard] <Insert classification>.
 - aa. Restaurant Seating Areas: [Light Hazard] <Insert classification>.

- bb. Restaurant Service Areas: **[Ordinary Hazard, Group 1] <Insert classification>**.
 - cc. Solvent Cleaning Areas: **[Extra Hazard, Group 2] <Insert classification>**.
 - dd. Stages: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - ee. Theaters and Auditoriums, excluding Stages and Prosceniums: **[Light Hazard] <Insert classification>**.
 - ff. Upholstering Plants: **[Extra Hazard, Group 1] <Insert classification>**.
 - gg. **<Insert occupancy and hazard classification>**.
4. Minimum Density for Automatic-Sprinkler Piping Design:
- a. Residential (Dwelling) Occupancy: **[0.05 gpm/sq. ft. over 400 sq. ft. (2.04 mm/min. over 37.2 sq. m)] <Insert value> area.**
 - b. Light-Hazard Occupancy: **[0.10 gpm/sq. ft. over 1500 sq. ft. (4.1 mm/min. over 140 sq. m)] <Insert value> area.**
 - c. Ordinary-Hazard, Group 1 Occupancy: **[0.15 gpm/sq. ft. over 1500 sq. ft. (6.1 mm/min. over 140 sq. m)] <Insert value> area.**
 - d. Ordinary-Hazard, Group 2 Occupancy: **[0.20 gpm/sq. ft. over 1500 sq. ft. (8.2 mm/min. over 140 sq. m)] <Insert value> area.**
 - e. Extra-Hazard, Group 1 Occupancy: **[0.30 gpm/sq. ft. over 2500 sq. ft. (12.2 mm/min. over 230 sq. m)] <Insert value> area.**
 - f. Extra-Hazard, Group 2 Occupancy: **[0.40 gpm/sq. ft. over 2500 sq. ft. (16.3 mm/min. over 230 sq. m)] <Insert value> area.**
 - g. Special Occupancy Hazard: As determined by AHJs.
5. Minimum Density for Deluge-Sprinkler Piping Design:
- a. Ordinary-Hazard, Group 1 Occupancy: **[0.15 gpm/sq. ft. 6.1 mm/min.] <Insert value> over entire area.**
 - b. Ordinary-Hazard, Group 2 Occupancy: **[0.20 gpm/sq. ft. 8.2 mm/min.] <Insert value> over entire area.**
 - c. Extra-Hazard, Group 1 Occupancy: **[0.30 gpm/sq. ft. 12.2 mm/min.] <Insert value> over entire area.**
 - d. Extra-Hazard, Group 2 Occupancy: **[0.40 gpm/sq. ft. 16.3 mm/min.] <Insert value> over entire area.**
 - e. Special Occupancy Hazard: As determined by AHJs.
6. Maximum protection area per sprinkler in accordance with UL listing.
7. Maximum Protection Area per Sprinkler:
- a. Residential Areas: **[400 sq. ft. (37 sq. m)] <Insert dimension>**.
 - b. Office Spaces: **[120 sq. ft. (11.1 sq. m)] [225 sq. ft. (20.9 sq. m)] <Insert dimension>**.
 - c. Storage Areas: **[130 sq. ft. (12.1 sq. m)] <Insert dimension>**.
 - d. Mechanical Equipment Rooms: **[130 sq. ft. (12.1 sq. m)] <Insert dimension>**.
 - e. Electrical Equipment Rooms: **[130 sq. ft. (12.1 sq. m)] <Insert dimension>**.
 - f. Other Areas: In accordance with **[NFPA 13] [NFPA 13R] [NFPA 13D]** recommendations unless otherwise indicated.
8. Total Combined Hose-Stream Demand Requirement: In accordance with NFPA 13 unless otherwise indicated:
- a. Light-Hazard Occupancies: **[100 gpm 6.3 L/s for 30 minutes] <Insert requirement>**.
 - b. Ordinary-Hazard Occupancies: **[250 gpm 15.75 L/s for 60 to 90 minutes] <Insert requirement>**.
 - c. Extra-Hazard Occupancies: **[500 gpm 31.5 L/s for 90 to 120 minutes] <Insert requirement>**.
9. Minimum residual pressure at each hose-connection outlet is as follows:

- a. NPS 1-1/2 (DN 40) Hose Connections: **[65 psig 450 kPa]** <Insert value>.
 - b. NPS 2-1/2 (DN 65) Hose Connections: **[100 psig 690 kPa]** <Insert value>.
 - H. Obtain documented approval of fire-suppression system design from AHJs.
- 1.3 FIRE-SUPPRESSION PIPING, FITTINGS, AND APPURTENANCES
- A. Steel Pipe, Fittings, and Appurtenances:
- 1. Schedule 40 Steel Pipe: **[Galvanized-]** **[and]** **[black-]** steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.
 - a. Standards:
 - 1) UL 852.
 - 2) FM 1630.
 - b. Factory-applied exterior coating.
 - c. Factory-applied bacterial-resistant internal coating to reduce microbiologically influenced corrosion.
 - d. Pipe ends may be factory or field formed to match joining method.
 - 2. Schedule 10 Steel Pipe: **[Galvanized-]** **[and]** **[black-]** steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.
 - a. Standards:
 - 1) UL 852.
 - 2) FM 1630.
 - b. Factory-applied exterior coating.
 - c. Factory-applied bacterial resistant internal coating to reduce microbiologically influenced corrosion.
 - d. Pipe ends may be factory or field formed to match joining method.
 - 3. Engineered Light-Wall Steel Pipe: **[Galvanized-]** **[and]** **[black-]** steel pipe, ASTM A135/A135M or ASTM A795/A795M with wall thickness less than Schedule 40. Outside dimension is to be equivalent to Schedule 40.
 - a. Standards:
 - 1) UL 852.
 - 2) FM 1630.
 - b. Factory-applied exterior coating.
 - c. Factory-applied bacterial-resistant internal coating to reduce microbiologically influenced corrosion.
 - d. Pipe ends may be factory or field formed to match joining method.
 - 4. Steel Pipe Nipples: **[Galvanized]** **[and]** **[black]** steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
 - 5. Steel Couplings: **[Galvanized]** **[and]** **[uncoated]** steel, ASTM A865/A865M, threaded.
 - 6. Gray-Iron Threaded Fittings: **[Galvanized]** **[and]** **[uncoated]** gray-iron threaded fittings, ASME B16.4, Class 125, standard pattern.
 - 7. Malleable- or Ductile-Iron Unions: ASME B16.3.
 - 8. Cast-Iron Flanges: ASME B16.1, Class 125.

9. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - a. Pipe-Flange Gasket Materials: **[AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick] [ASME B16.21, nonmetallic and asbestos free] [or] [EPDM rubber gasket]**.
 - 1) Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - 2) Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - b. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.
10. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
 - a. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
11. Plain-End-Pipe Fittings:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1) Gruvlok; an ASC Engineered Solution.
 - 2) Shurjoint; a part of Aalberts Integrated piping Systems.
 - 3) Victaulic Company.
 - 4) **<Insert manufacturer's name>**.
 - b. Pressure Rating: **[175 psig 1200 kPa] [250 psig 1725 kPa] [300 psig 2070 kPa]** minimum.
 - c. Plain-End Fittings for Steel Piping: **[Galvanized] [Painted] [Uncoated]** plain-end fittings, ASTM A53/A53M, carbon steel or ASTM A106/A106M, forged steel with dimensions matching steel pipe.
 - d. Plain-End-Pipe Couplings for Steel Piping: Rigid pattern for steel-pipe dimensions, ductile-iron or malleable-iron housing. Include EPDM-rubber gasket, and bolts and nuts.
12. Grooved-Joint, Steel-Pipe Appurtenances:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1) CPS Products, Inc.
 - 2) Gruvlok; an ASC Engineered Solution.
 - 3) Shurjoint; a part of Aalberts Integrated piping Systems.
 - 4) Smith-Cooper International.
 - 5) SPF/Anvil; an ASC Engineered Solution.
 - 6) Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - 7) Victaulic Company.
 - 8) **<Insert manufacturer's name>**.
 - b. Pressure Rating: **[175 psig 1200 kPa] [250 psig 1725 kPa] [300 psig (2070 kPa)]** minimum.

- c. Grooved-End Fittings for Steel Piping: **[Galvanized] [Painted] [Uncoated]** grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
 - d. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- 13. Carbon Steel Pressure-Seal Fittings: UL 213, FM Approvals-approved, 175 psig (1200 kPa) pressure rating with carbon steel-, zinc-nickel-coated housing, EDPM O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1) Mueller Streamline Co.; a company of Mueller Industries.
 - 2) Viega LLC.
 - 3) **<Insert manufacturer's name>**.
- B. Stainless Steel Pipe, Fittings, and Appurtenances:
 - 1. Stainless Steel Pipe: ASTM A312/A312M, **[Type 304/304L] [Type 316/316L]**, Schedule 10S, dimensions conforming to ASME B36.19M.
 - 2. Stainless Steel Pipe Fittings: ASTM A403/A403M.
 - 3. Fittings for Grooved-End, Stainless Steel Pipe:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1) GroovJoint.
 - 2) **<Insert manufacturer's name>**.
 - b. Source Limitations: Obtain appurtenance for grooved-end, stainless steel pipe from single manufacturer.
 - c. Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.
 - 4. Mechanical Couplings for Grooved-End, Stainless Steel Pipe:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1) GroovJoint.
 - 2) **<Insert manufacturer's name>**.
 - b. AWWA C606 for stainless steel pipe dimensions.
 - c. Stainless steel housing sections.
 - d. Stainless steel bolts and nuts.
 - e. EPDM-rubber gaskets suitable for hot and cold water.
 - f. Minimum Pressure Rating:
 - 1) NPS 8 (DN 200) and Smaller: **[600 psig 4137 kPa] <Insert value>**.
 - 2) NPS 10 and NPS 12 (DN 250 to DN 300): **[400 psig 2758 kPa] <Insert value>**.
 - 3) NPS 14 to NPS 24 (DN 350 to DN 600): **[250 psig 1725 kPa] <Insert value>**.

5. Stainless Steel Piping, Pressure-Seal-Joint Fittings:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1) GroovJoint.
 - 2) Merit Brass Company.
 - 3) Victaulic Company.
 - 4) Viega LLC.
 - 5) **<Insert manufacturer's name>**.
 - b. Source Limitations: Obtain pressure-seal-joint fittings from single manufacturer.
 - c. Material: **[Type 304] [Type 316]** stainless steel, ASTM A312/A312M.
 - d. Fittings: **[Type 304] [Type 316]** stainless steel with EPDM O-ring seal in each end, and FM approved for fire protection applications.
6. Grooved, Mechanical-Joint, Copper-Tube Appurtenances:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1) Gruvlok; an ASC Engineered Solution.
 - 2) Shurjoint; a part of Aalberts Integrated piping Systems.
 - 3) Victaulic Company.
 - 4) **<Insert manufacturer's name>**.
 - b. Standard: UL 213.
 - c. Grooved-End Copper Fittings: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
 - d. Grooved-End-Tube Couplings: To fit copper tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM-rubber gasket rated for minimum **[180 deg F (80 deg C)] <Insert temperature>** for use with ferrous housing and steel bolts and nuts; 300 psig 2070 kPa minimum CWP pressure rating.
7. Copper-Tube, Pressure-Seal-Joint Fittings:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1) Viega LLC.
 - 2) **<Insert manufacturer's name>**.
 - b. Fittings: Cast brass, cast bronze, or wrought copper with EPDM O-ring seal in each end.
 - c. Minimum 200 psig 1379 kPa working-pressure rating at 250 deg F (121 deg C).
- C. CPVC Pipe, Fittings, and Appurtenances:
 1. CPVC Pipe: ASTM F442/F442M and UL 1821, SDR 13.5, for 175 psig 1200 kPa rated pressure at 150 deg F (62 deg C), with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.

2. CPVC Fittings: **[UL listed] [or] [FM Approvals approved]**, for 175 psig 1200 kParated pressure at 150 deg F (62 deg C), socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.
 - a. NPS 3/4 to NPS 1-1/2 DN 20 to DN 40: ASTM F438 and UL 1821, Schedule 40, socket type.
 - b. NPS 2 to NPS 3 DN 50 to DN 80: ASTM F439 and UL 1821, Schedule 80, socket type.
 - c. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
 - d. CPVC-to-Metal Transition Unions: CPVC, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
 - e. Flanges: CPVC, one or two pieces.
3. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493 solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.
4. Adhesive primer shall have a VOC content of 550 g/L or less.
5. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
6. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
8. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
9. Solvent cement shall have a VOC content of 490 g/L or less.
10. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
11. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
12. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
13. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
14. Plastic Pipe-Flange Gasket and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

1.4 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connection, Exposed Type:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Croker; a Division of Morris Group International.
 - b. Elkhart Brass Mfg. Co., Inc.
 - c. Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International.
 - d. Guardian Fire Equipment, Inc.
 - e. Potter Roemer LLC; a Division of Morris Group International.
 - f. Wilson & Cousins Inc.
 - g. **<Insert manufacturer's name>.**
2. Standard: UL 405.
3. Description: Exposed, projecting, for wall mounting.
4. Pressure Rating: 175 psig 1200 kPa minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, wall type.
9. Outlet: Back, with pipe threads.
10. Number of Inlets: **[Two] [Three]**.
11. Escutcheon Plate Marking: **["AUTO SPKR & STANDPIPE"] ["STANDPIPE"] ["AUTO SPKR"] <Insert marking>.**
12. Finish: **[Polished chrome plated] [Rough brass or bronze] [Rough chrome plated]**.
13. Outlet Size: **[NPS 4 DN 100] [NPS 6 DN 150]**.

B. Fire Department Connection, Flush Type:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Croker; a Division of Morris Group International.
 - b. Elkhart Brass Mfg. Co., Inc.
 - c. Guardian Fire Equipment, Inc.
 - d. Potter Roemer LLC; a Division of Morris Group International.
 - e. Wilson & Cousins Inc.
 - f. **<Insert manufacturer's name>.**
2. Standard: UL 405.
3. Description: Flush, for wall mounting.
4. Pressure Rating: 175 psig 1200 kPa minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Rectangular, brass, wall type.
9. Outlet: With pipe threads.

10. Body Style: **[Horizontal] [Square] [Vertical]**.
11. Number of Inlets: **[Two] [Three] [Four] [Six]**.
12. Outlet Location: **[Back] [Bottom] [Left side] [Right side] [Top]**.
13. Escutcheon Plate Marking: **["AUTO SPKR & STANDPIPE"] ["STANDPIPE"] ["AUTO SPKR"] <Insert marking>**.
14. Finish: **[Polished chrome plated] [Rough brass or bronze] [Rough chrome plated]**.
15. Outlet Size: **[NPS 4 DN 100] [NPS 6 DN 150] [NPS 8 DN 200]**.

C. Fire Department Connection, Yard Type:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Croker; a Division of Morris Group International.
 - b. Elkhart Brass Mfg. Co., Inc.
 - c. Guardian Fire Equipment, Inc.
 - d. Potter Roemer LLC; a Division of Morris Group International.
 - e. **<Insert manufacturer's name>**.
2. Standard: UL 405.
3. Description: Exposed, freestanding.
4. Pressure Rating: **[175 psig 1200 kPa minimum] [300 psig 2070 kPa]**.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, floor type.
9. Outlet: Bottom, with pipe threads.
10. Number of Inlets: **[Two] [Three] [Four]**.
11. Sleeve: **[Brass] [Not required]**.
12. Sleeve Height: 18 inches 460 mm.
13. Escutcheon Plate Marking: **["AUTO SPKR & STANDPIPE"] ["STANDPIPE"] ["AUTO SPKR"] <Insert marking>**.
14. Finish, Including Sleeve: **[Polished chrome plated] [Rough brass or bronze] [Rough chrome plated]**.
15. Outlet Size: **[NPS 4 DN 100] [NPS 6 DN 150]**.

D. Fire Department Connection, Auxiliary Type:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Croker; a Division of Morris Group International.
 - b. Guardian Fire Equipment, Inc.
 - c. Potter Roemer LLC; a Division of Morris Group International.
 - d. **<Insert manufacturer's name>**.
2. Standard: UL 405.
3. Type: **[Exposed] [Flush] [Yard (Freestanding)]**.
4. Pressure Rating: 175 psig 1200 kPa minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Universal, threadless (Storz) connector in accordance with NFPA 1963.
7. Caps: Corrosion-resistant metal, with gasket and chain.

8. Escutcheon Plate: Round, brass.
9. Outlet: Back, with pipe threads.
10. Number of Inlets: One.
11. Escutcheon Plate Marking: ["**AUTO SPKR & STANDPIPE**"] ["**STANDPIPE**"] ["**AUTO SPKR**"].
12. Finish: [**Polished chrome plated**] [**Polished brass**] [**Powder coat**].
13. Outlet Size: [**NPS 4 DN 100**] [**NPS 6 DN 150**].

1.5 HOSE CONNECTIONS AND HOSE STATIONS

A. Hose Connections, Adjustable Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
 - a. Brooks Equipment Co., Inc.
 - b. Croker; a Division of Morris Group International.
 - c. Elkhart Brass Mfg. Co., Inc.
 - d. Guardian Fire Equipment, Inc.
 - e. Potter Roemer LLC; a Division of Morris Group International.
 - f. Wilson & Cousins Inc.
 - g. Zurn Industries, LLC.
 - h. **<Insert manufacturer's name>**.
2. Standards:
 - a. UL 668.
 - b. UL 1468.
3. Description: Fire hose valve, with integral reducing or restricting pressure-control device, for connecting fire hose.
4. Pressure Rating: 175 psig 1200 kPa maximum inlet.
5. Material: Brass or bronze.
6. Size: NPS 1-1/2 or NPS 2-1/2 DN 40 or DN 65, as indicated.
7. Inlet: Female pipe threads.
8. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire department threads.
9. Pattern: [**Angle**] [**or**] [**gate**].
10. Pressure-Control Device Type: Pressure [**reducing**] [**restricting**].
11. Design Outlet Pressure Setting: **<Insert psig kPa>**.
12. Finish: [**Polished chrome plated**] [**Rough brass or bronze**] [**Rough chrome plated**].

B. Hose Connections, Nonadjustable Valve:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
 - a. Brooks Equipment Co., Inc.
 - b. Croker; a Division of Morris Group International.
 - c. Elkhart Brass Mfg. Co., Inc.
 - d. Guardian Fire Equipment, Inc.
 - e. Potter Roemer LLC; a Division of Morris Group International.
 - f. Wilson & Cousins Inc.
 - g. Zurn Industries, LLC.
 - h. **<Insert manufacturer's name>**.

2. Standard: UL 668.
 3. Description: Fire hose valve for connecting fire hose.
 4. Pressure Rating: 300 psig 2070 kPa minimum.
 5. Material: Brass or bronze.
 6. Size: NPS 1-1/2 or NPS 2-1/2DN 40 or DN 65, as indicated.
 7. Inlet: Female pipe threads.
 8. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire department threads.
 9. Pattern: **[Angle] [or] [gate]**.
 10. Finish: **[Polished chrome plated] [Rough brass or bronze] [Rough chrome plated]**.
- C. Hose Stations, Rack Type, NPS 1-1/2DN 40:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Brooks Equipment Co., Inc.
 - b. Croker; a Division of Morris Group International.
 - c. Guardian Fire Equipment, Inc.
 - d. Potter Roemer LLC; a Division of Morris Group International.
 - e. Wilson & Cousins Inc.
 - f. **<Insert manufacturer's name>**.
 2. Hose Rack:
 - a. Standard: UL 47.
 - b. Material: **[Brass or bronze with polished chrome-plated] [Steel with red-enamel] finish**.
 - c. Type: Hose-rack assembly. Include hose valve, hose rack, water-retention device, hose pins, and hose.
 - d. Operation: Semiautomatic.
 - e. Sized to hold fire hose.
 3. Hose Valve:
 - a. Standards:
 - 1) UL 668.
 - 2) UL 1468.
 - b. NPS 1-1/2 DN 40, for connecting fire hose.
 - c. Type: **[Adjustable] [Nonadjustable]**.
 - d. Pressure-Control Device: **[Pressure reducing] [or] [pressure restricting]**, UL 1468 integral or for field installation if indicated.
 - e. Design Outlet Pressure Setting: **[Not applicable] <Insert psigkPa>**.
 - f. Hose Valve and Trim Finish: **[Polished chrome-plated] [Rough brass or bronze] [Rough chrome-plated]**.
 - g. Pressure Rating: 300 psig2070 kPa minimum.
 - h. Pattern: Angle.
 - i. Material: Brass or bronze.
 - j. Size: NPS 1-1/2DN 40.
 - k. Inlet: Female pipe threads.
 - l. Outlet: Male hose threads in accordance with NFPA 1963 and matching local fire department threads.

4. Hose:
 - a. Standards:
 - 1) NFPA 1961.
 - 2) UL 219.
 - 3) UL 401.
 - b. Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
 - c. Size: NPS 1-1/2/DN 40.
 - d. Length: **[50 ft. 15 m] [75 ft. 23 m] [100 ft. 30 m] <Insert dimension>**.
 - e. Jacket: **[Combination of natural and synthetic threads] [Natural thread] [Synthetic thread]**.
 - f. Lining: **[Rubber, plastic, or combination of rubber and plastic compounds] [Combination of rubber and plastic compounds] [Rubber compound] [Plastic compound]**.
 - g. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
 - h. Nozzle:
 - 1) Material: **[Brass] [Polished brass] [Rough chrome-plated brass] [Polished chrome-plated brass] [Polycarbonate plastic]**.
 - 2) Type: **[Plain, for nonadjustable water stream] [Spray, adjustable from shutoff to fog spray or straight stream] [Spray, adjustable from shutoff to full fog; for use on electrical fires]**.
- D. Hose Stations, Rack Type, NPS 1-1/2 by NPS 2-1/2/DN 40 by DN 65:
 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Brooks Equipment Co., Inc.
 - b. Croker; a Division of Morris Group International.
 - c. Guardian Fire Equipment, Inc.
 - d. Potter Roemer LLC; a Division of Morris Group International.
 - e. Wilson & Cousins Inc.
 - f. **<Insert manufacturer's name>**.
 2. Hose Rack:
 - a. Standard: UL 47.
 - b. Material: **[Brass or bronze with polished chrome-plated] [Steel with red-enamel] finish**.
 - c. Type: Hose-rack assembly. Include hose valve, reducer adapter, hose rack, water-retention device, hose pins, and hose.
 - d. Operation: Semiautomatic.
 - e. Sized to hold fire hose.
 3. Hose Valve:
 - a. Standards:
 - 1) UL 668.
 - 2) UL 1468.
 - 3) NFPA 1963.
 - b. NPS 2-1/2 (DN 65), for connecting fire hose.
 - c. Type: **[Adjustable] [Nonadjustable]**.

- d. Pressure-Control Device: **[Pressure reducing]** [or] **[pressure restricting]**, UL 1468 integral or for field installation if indicated.
 - e. Design Outlet Pressure Setting: **[Not applicable]** <Insert psig kPa>.
 - f. Hose Valve and Trim Finish: **[Polished chrome plated]** **[Rough brass or bronze]** **[Rough chrome plated]**.
 - g. Pressure Rating: 300 psig 2070 kPa minimum.
 - h. Pattern: Angle.
 - i. Material: Brass or bronze.
 - j. Size: NPS 2-1/2 DN 65.
 - k. Inlet: Female pipe threads.
 - l. Outlet: Male hose threads and matching local fire department threads.
 - m. Reducer Adapter: NPS 2-1/2 by NPS 1-1/2 DN 65 by DN 40.
4. Hose:
- a. Standards:
 - 1) UL 219.
 - 2) UL 401.
 - 3) NFPA 1961.
 - b. Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
 - c. Size: NPS 1-1/2 DN 40.
 - d. Length: **[50 ft. 15 m]** **[75 ft. 23 m]** **[100 ft. 30 m]** <Insert dimension>.
 - e. Jacket: **[Combination of natural and synthetic threads]** **[Natural thread]** **[Synthetic thread]**.
 - f. Lining: **[Rubber, plastic, or combination of rubber and plastic compounds]** **[Combination of rubber and plastic compounds]** **[Rubber compound]** **[Plastic compound]**.
 - g. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
 - h. Nozzle: Spray nozzle unless plain nozzle is indicated.
 - 1) Material: **[Brass]** **[Polished brass]** **[Rough chrome-plated brass]** **[Polished chrome-plated brass]** **[Polycarbonate plastic]**.
 - 2) Type: **[Plain, for nonadjustable water stream]** **[Spray, adjustable from shutoff to fog spray or straight stream]** **[Spray, adjustable from shutoff to full fog; for use on electrical fires]**.
- E. Hose Stations, Reel Type, NPS 1-1/2 DN 40:
- 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Brooks Equipment Co., Inc.
 - b. Croker; a Division of Morris Group International.
 - c. Guardian Fire Equipment, Inc.
 - d. Potter Roemer LLC; a Division of Morris Group International.
 - e. Wilson & Cousins Inc.
 - f. **<Insert manufacturer's name>**.
 - 2. Hose Reel:
 - a. Standard: UL 47.
 - b. Hose Reel and Bracket Material: Steel.
 - c. Description: Hose-reel assembly. Include hose valve, wall bracket, hose reel, water-retention device, hose pins, and hose.
 - d. Operation: Semiautomatic.

- e. Sized to hold fire hose.
 - f. Finish: Red enamel.
- 3. Hose Valve:
 - a. Standards:
 - 1) UL 668.
 - 2) UL 1468.
 - 3) NFPA 1963.
 - b. NPS 1-1/2DN 40, for connecting fire hose.
 - c. Type: **[Adjustable] [Nonadjustable]**.
 - d. Pressure-Control Device: **[Pressure reducing] [or] [pressure restricting]**, UL 1468 integral or for field installation if indicated.
 - e. Design Outlet Pressure Setting: **[Not applicable] <Insert psigkPa>**.
 - f. Hose Valve and Trim Finish: **[Polished chrome plated] [Rough brass or bronze] [Rough chrome plated]**.
 - g. Pressure Rating: 300 psig2070 kPa minimum.
 - h. Pattern: Angle.
 - i. Material: Brass or bronze.
 - j. Size: NPS 1-1/2DN 40.
 - k. Inlet: Female pipe threads.
 - l. Outlet: Male hose threads and matching local fire department threads.
- 4. Hose:
 - a. Standards:
 - 1) UL 219.
 - 2) UL 401.
 - 3) NFPA 1961.
 - b. Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
 - c. Size: NPS 1-1/2DN 40.
 - d. Length: **[50 ft. 15 m] [75 ft. 23 m] [100 ft. 30 m] <Insert dimension>**.
 - e. Jacket: **[Combination of natural and synthetic threads] [Natural thread] [Synthetic thread]**.
 - f. Lining: **[Rubber, plastic, or combination of rubber and plastic compounds] [Combination of rubber and plastic compounds] [Rubber compound] [Plastic compound]**.
 - g. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
 - h. Nozzle:
 - 1) Material: **[Brass] [Polished brass] [Rough chrome-plated brass] [Polished chrome-plated brass] [Polycarbonate plastic]**.
 - 2) Type: Spray, adjustable from shutoff to **[fog spray or straight stream] [full fog; for use on electrical fires]**.

1.6 SYSTEM CONTROL VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
- B. Pressure Rating:
 - 1. Standard-Pressure Piping Valves: 175 psig 1200 kPa minimum.
 - 2. High-Pressure Piping Valves: **[250 psig 1725 kPa minimum] [300 psig 2070 kPa]**.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.

- E. End Connections: Flanged or grooved.
- F. System Control Valve, Alarm Valve:
 - 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - c. Venus Fire Protection Ltd.
 - d. Victaulic Company.
 - e. Viking Group Inc.
 - f. **<Insert manufacturer's name>.**
 - 2. Standard: UL 193.
 - 3. Design: For horizontal or vertical installation.
 - 4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, **[retarding chamber,]** and fill-line attachment with strainer.
 - 5. Drip cup assembly ppe drain **[without valves and separate from main drain piping] [with check valve to main drain piping].**
- G. System Control Valve, Dry-Pipe Valve:
 - 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - c. Venus Fire Protection Ltd.
 - d. Victaulic Company.
 - e. Viking Group Inc.
 - f. **<Insert manufacturer's name>.**
 - 2. Standards:
 - a. UL 260.
 - b. UL 1486.
 - 3. Design: Differential-pressure type.
 - 4. Include quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
 - 5. Air-Pressure Maintenance Device for Dry-Pipe Valve:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) General Air Products, Inc.
 - 2) Potter Electric Signal Company, LLC.
 - 3) Reliable Automatic Sprinkler Co., Inc. (The).
 - 4) Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.

- 5) Venus Fire Protection Ltd.
 - 6) Victaulic Company.
 - 7) Viking Group Inc.
 - 8) **<Insert manufacturer's name>.**
 - b. Standard: UL 260.
 - c. Description: Automatic device to maintain minimum air pressure in piping.
 - d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14 to 60 psig (95 to 410 kPa) adjustable range, and **[175 psig (1200 kPa)] [300 psig (2070 kPa)]** outlet pressure.
6. Air Compressor for Dry-Pipe Valve:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Gast Manufacturing Inc.
 - 2) General Air Products, Inc.
 - 3) Viking Group Inc.
 - 4) **<Insert manufacturer's name>.**
 - b. Motor Horsepower: Fractional.
 - c. Power: 120 V ac, 60 Hz, single phase.
 - d. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA standards. Provide ASME air receiver tank as required to meet requirements on larger systems.
 - e. Include filters, relief valves, coolers, automatic drains, and gauges.
- H. System Control Valve, Deluge Valve:
 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. BERMAD Control Valves.
 - b. CLA-VAL.
 - c. OCV Control Valves.
 - d. Reliable Automatic Sprinkler Co., Inc. (The).
 - e. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - f. Venus Fire Protection Ltd.
 - g. Victaulic Company.
 - h. Viking Group Inc.
 - i. **<Insert manufacturer's name>.**
 2. Standard: UL 260.
 3. Design: Hydraulically operated, differential-pressure type.
 4. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
 5. Wet, Pilot-Line Trim Set: Include gauge to read diaphragm-chamber pressure and manual control station for manual operation of deluge valve, and connection for actuation device.

I. System Control Valve, Preaction Valve:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. BERMAD Control Valves.
 - b. OCV Control Valves.
 - c. Reliable Automatic Sprinkler Co., Inc. (The).
 - d. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - e. Venus Fire Protection Ltd.
 - f. Victaulic Company.
 - g. Viking Group Inc.
 - h. **<Insert manufacturer's name>.**
2. Standard: UL 260.
3. Design: Hydraulically operated, differential-pressure type.
4. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
5. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gauges; low-air-pressure warning switch; air-relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
6. Air-Pressure Maintenance Device for Preaction Valve:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Reliable Automatic Sprinkler Co., Inc. (The).
 - 2) Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - 3) Venus Fire Protection Ltd.
 - 4) Victaulic Company.
 - 5) Viking Group Inc.
 - 6) **<Insert manufacturer's name>.**
 - b. Standard: UL 260.
 - c. Description: Automatic device to maintain minimum air pressure in piping.
 - d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14 to 60 psig (95 to 410 kPa) adjustable range, and **[175 psig (1200 kPa)] [300 psig (2070 kPa)]** outlet pressure.
7. Air Compressor for Preaction Valve:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Gast Manufacturing Inc.

- 2) General Air Products, Inc.
 - 3) Viking Group Inc.
 - 4) **<Insert manufacturer's name>.**
- b. Motor Horsepower: Fractional.
 - c. Power: 120 V ac, 60 Hz, single phase.
 - d. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA standards. Provide ASME air receiver tank as required to meet requirements on larger systems.
 - e. Include filters, relief valves, coolers, automatic drains, and gauges.

1.7 DRY-SPRINKLER SYSTEM NITROGEN GENERATOR WITH PURGE/VENT

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
1. Engineered Corrosion Solutions.
 2. General Air Products, Inc.
 3. Potter Electric Signal Company, LLC.
 4. South-Tek Systems, LLC.
 5. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 6. UNITED Fire Systems.
 7. **<Insert manufacturer's name>.**
- B. Description: Nitrogen generator system to serve dry sprinkler zones for piping corrosion mitigation, including system venting. System is to provide required supervisory pressure within sprinkler zone. System is to include either an integrated, oil-less air compressor, located within the nitrogen generator system package, or a separate vibration-isolation mounted air compressor, also provided by nitrogen generator manufacturer.
- C. Standards:
1. FM 1035.
 2. UL 508A.
- D. Nitrogen Generator:
1. **[Wall-mounted] [skid-mounted] [or] [stand-alone]** nitrogen generator to provide minimum nitrogen purity of 98 percent to the designated sprinkler systems.
 2. Power: 120 V ac.
 3. Bypass mode and nitrogen-generating mode.
 4. Minimum Capacity: **[As recommended by manufacturer] <Insert requirements>.**
- E. Air Compressor:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
 2. Motor Horsepower: Fractional.
 - a. Power: 120 V ac, 60 Hz, single phase.
 3. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
 4. Include filters, relief valves, coolers, automatic drains, and gauges.
 5. Minimum Capacity: Match capacity of nitrogen generator.
- F. Automatic Purge Vent/Valve:
1. Vents oxygen during system nitrogen fill.

2. Automatically closes when 98 percent minimum nitrogen has been reached.
 3. Sized to allow correct purge rate per manufacturer's written instructions and with **[14 days]** **<Insert period>**.
 4. Provide one venting device for each dry/preaction sprinkler system zone.
 5. Include a connection port for a portable nitrogen purity sensor or a nitrogen purity manifold.
- G. Supervisory Gas Monitoring - Nitrogen Purity Sensing Device:
1. Portable Handheld Nitrogen Purity Sensing Device: Portable sensing device to connect to the outlet of the automatic purge/vent valve during periodic inspections to obtain a nitrogen purity reading within each zone.
 2. Permanently Mounted Nitrogen Purity Monitoring Device or Manifold: Permanent monitoring device to continuously monitor system's nitrogen purity.
- H. BAS Alarm Integration:
1. Provide nitrogen-generation system with integrated leak-detection and bypass alarms. Program alarms into controller **[and connect to BAS]**.
 - a. Leak-detection system is to alarm if leaks develop within fire-suppression system piping.
 - b. Air bypass alarm is to activate if nitrogen-generation system is bypassed by air compressor.
- 1.8 PREACTION SPRINKLER SYSTEM NITROGEN GENERATOR WITH PURGE/VENT
- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
1. Engineered Corrosion Solutions.
 2. General Air Products, Inc.
 3. Potter Electric Signal Company, LLC.
 4. South-Tek Systems, LLC.
 5. **<Insert manufacturer's name>**.
- B. Description: Nitrogen generator system to serve preaction sprinkler zones for piping corrosion mitigation, including system venting. System is to provide required supervisory pressure within sprinkler zone. System is to include either an integrated, oil-less air compressor, located within the nitrogen generator system package, or a separate vibration-isolation mounted air compressor, also provided by nitrogen generator manufacturer.
- C. Standards:
1. FM 1035.
 2. UL 508A.
- D. Nitrogen Generator:
1. **[Wall-mounted]** **[skid-mounted]** **[or]** **[stand-alone]** nitrogen generator to provide minimum nitrogen purity of 98 percent to the designated sprinkler systems.
 2. Power: 120 V ac.
 3. Bypass mode and nitrogen-generating mode.
 4. Minimum Capacity: **[As recommended by manufacturer]** **<Insert requirements>**.
- E. Air Compressor:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
 2. Motor Horsepower: Fractional.
 - a. Power: 120 V ac, 60 Hz, single phase.

3. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
 4. Include filters, relief valves, coolers, automatic drains, and gauges.
 5. Minimum Capacity: Match capacity of nitrogen generator.
- F. Automatic Purge Vent/Valve:
1. Vents oxygen during system nitrogen fill.
 2. Automatically closes when 98 percent minimum nitrogen has been reached.
 3. Sized to allow correct purge rate per manufacturer's written instructions and with **[14 days] <Insert period>**.
 4. Provide one venting device for each dry/preaction sprinkler system zone.
 5. Include a connection port for a portable nitrogen purity sensor or a nitrogen purity manifold.
- G. Supervisory Gas Monitoring - Nitrogen Purity Sensing Device:
1. Portable Handheld Nitrogen Purity Sensing Device: Portable sensing device to connect to the outlet of automatic purge/vent valve during periodic inspections to obtain a nitrogen purity reading within each zone.
 2. Permanently Mounted Nitrogen Purity Monitoring Device or Manifold: Permanent monitoring device to continuously monitor system's nitrogen purity.
- H. BAS Alarm Integration:
1. Provide nitrogen-generation system with integrated leak-detection and bypass alarms. Program alarms into controller **[and connect to BAS]**.
 - a. Leak-detection system is to alarm if leaks develop within fire-suppression system piping.
 - b. Air bypass alarm is to alarm if nitrogen-generation system is bypassed by air compressor.
- 1.9 FIRE-SUPPRESSION PIPING SPECIALTIES
- A. Branch Outlet Fittings:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Shurjoint; a part of Aalberts Integrated piping Systems.
 - b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - c. Victaulic Company.
 - d. **<Insert manufacturer's name>**.
 2. Standard: UL 213.
 3. Pressure Rating: **[175 psig 1200 kPa minimum] [300 psig 2070 kPa]**.
 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 5. Type: Mechanical-tee and -cross fittings.
 6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. AGF Manufacturing, Inc.
 - b. Reliable Automatic Sprinkler Co., Inc. (The).
 - c. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - d. Victaulic Company.
 - e. **<Insert manufacturer's name>**.
2. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
3. Pressure Rating: **[175 psig 1200 kPa minimum] [300 psig 2070 kPa]**.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. AGF Manufacturing, Inc.
 - b. Croker; a Division of Morris Group International.
 - c. Potter Roemer LLC; a Division of Morris Group International.
 - d. **<Insert manufacturer's name>**.
2. Standard: UL 199.
3. Pressure Rating: 175 psig 1200 kPa.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. AGF Manufacturing, Inc.
 - b. Reliable Automatic Sprinkler Co., Inc. (The).
 - c. Viking Group Inc.
 - d. **<Insert manufacturer's name>**.
2. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
3. Pressure Rating: **[175 psig 1200 kPa minimum] [300 psig 2070 kPa]**.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Aegis Technologies, Inc.
 - b. **<Insert manufacturer's name>.**
2. Standard: UL 1474.
3. Pressure Rating: **[250 psig 1725 kPa minimum] [300 psig 2070 kPa].**
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. ALEUM USA.
 - b. Easyflex, Inc.
 - c. Flexhead; an ASC Engineered Solution.
 - d. Gateway Tubing, Inc.
 - e. Victaulic Company.
 - f. **<Insert manufacturer's name>.**
2. Standards:
 - a. UL 2443.
 - b. FM 1637.
3. Description: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: **[175 psig 1200 kPa minimum] [300 psig (2070 kPa)].**
5. Size: Same as connected piping, for sprinkler.

G. Automatic (Ball-Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Viking Group Inc.
 - c. **<Insert manufacturer's name>.**
2. Pressure Rating: 175 psig 1200 kPa minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 (DN 20).
5. End Connections: Threaded.

H. Manual Air Vent/Valve:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. AGF Manufacturing, Inc.
 - b. **<Insert manufacturer's name>.**
2. Description: Ball valve that requires human intervention to vent air.
3. Body: Forged brass.
4. Ends: Threaded.
5. Minimize Size: 1/2 inch13 mm.
6. Minimum Water Working Pressure Rating: 300 psig2070 kPa.

I. Automatic Air Vent:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. AGF Manufacturing, Inc.
 - b. CLA-VAL.
 - c. Engineered Corrosion Solutions.
 - d. Metraflex Company (The).
 - e. Reliable Automatic Sprinkler Co., Inc. (The).
 - f. **<Insert manufacturer's name>.**
2. Description: Automatic air vent that automatically vents trapped air without human intervention. Approved for use in wet-pipe fire-suppression system.
3. Vents oxygen continuously from system.
4. Float valve to prevent water discharge.
5. Minimum Water Working Pressure Rating: 175 psig1207 kPa.

J. Automatic Air Vent Assembly:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. AGF Manufacturing, Inc.
 - b. Engineered Corrosion Solutions.
 - c. South-Tek Systems, LLC.
 - d. **<Insert manufacturer's name>.**
2. Description: Automatic **[dual]**air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly. Approved for use in wet-pipe fire-suppression system.
3. Vents oxygen continuously from system.
4. Float valve to prevent water discharge.
5. Minimum Water Working Pressure Rating: 175 psig1207 kPa.
6. **<Insert additional requirements specific to manufacturers>.**

1.10 COVER SYSTEMS FOR SPRINKLER PIPING

A. Cover System, Extruded PVC:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. DecoShield Systems, Inc.
 - b. **<Insert manufacturer's name>.**
2. Description: System of support brackets and covers designed to protect sprinkler piping.
3. Brackets: Per cover manufacturer.
4. Covers: Factory-fabricated extruded-PVC cover with concealed attachment clips.

B. Cover System, Fabricated Steel:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. JG Innovations, Inc.
 - b. **<Insert manufacturer's name>.**
2. Description: System of support brackets and covers designed to protect sprinkler piping.
3. Brackets: Per cover manufacturer.
4. Covers: Factory-fabricated steel cover with concealed attachment clamps.
 - a. Stainless Steel with #4 Finish: **[16] [18] [20] [22] [24]** gauge.
 - b. Cold-Rolled Steel: **[18] [20] [22] [24]** gauge.
 - 1) Zinc-galvanized treated to accept painting but not painted.
 - 2) Zinc galvanized, factory treated, and factory painted in colors selected by Architect from manufacturers standard/custom colors.
 - 3) Zinc galvanized, factory treated, and factory primed.

1.11 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

1. Reliable Automatic Sprinkler Co., Inc. (The).
2. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
3. Victaulic Company.
4. Viking Group Inc.
5. **<Insert manufacturer's name>.**

B. Standards:

1. UL 199.
2. UL 1767.
3. UL 1626.
4. FM 2000.
5. FM 2008.
6. FM 2030.

C. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."

D. Pressure Rating for Sprinklers:

Standard Automatic Sprinklers: 175 psig (1200 kPa) minimum.

1. High-Pressure Automatic Sprinklers: **[250 psig (1725 kPa) minimum] [300 psig (2070 kPa)]**.
2. Residential Sprinklers: 175 psig (1200 kPa) maximum.

E. Sprinklers, Automatic Wet with Heat-Responsive Element:

1. Characteristics: Nominal 1/2-inch (13-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
2. Standard Spray, Standard Response:
 - a. Upright.
 - b. Pendent.
 - c. Recessed pendent.
 - d. Flat, concealed pendent.
 - e. Vertical sidewall.
 - f. Horizontal sidewall.
3. Standard Spray, Quick Response:
 - a. Upright.
 - b. Pendent.
 - c. Recessed pendent.
 - d. Flat, concealed pendent.
 - e. Vertical sidewall.
 - f. Horizontal sidewall.
 - g. Flat, concealed horizontal sidewall.
4. Extended Coverage:
 - a. Upright.
 - b. Pendent.
 - c. Flat, concealed pendent.
 - d. Horizontal sidewall.
 - e. Flat, concealed horizontal sidewall.
5. Residential:
 - a. Recessed pendent.
 - b. Flat, concealed pendent.
 - c. Flat, concealed horizontal sidewall.

F. Sprinklers, Automatic Dry with Heat-Responsive Element:

1. Standard Spray, Standard Response:
 - a. Upright.
 - b. Pendent.
 - c. Recessed pendent.
 - d. Flat, concealed pendent.
 - e. Horizontal sidewall.
2. Standard Spray, Quick Response:
 - a. Upright.
 - b. Pendent.
 - c. Recessed pendent.
 - d. Flat, Concealed pendent.

- e. Horizontal sidewall.
 - f. Flat, concealed horizontal sidewall.
 - G. Special Sprinklers:
 - 1. Attic.
 - 2. Combustible, concealed.
 - 3. ESFR.
 - 4. Flat spray.
 - 5. Hallway.
 - 6. Institutional.
 - 7. MRI/Non-Ferrous, concealed.
 - 8. Window.
 - H. Open Sprinklers and Nozzles:
 - 1. Nominal Orifice:
 - a. 1/2 inch (13 mm), with discharge coefficient K between **[5.3 and 5.8]** <Insert value>.
 - b. 17/32 inch (13.5 mm) with discharge coefficient K between **[7.4 and 8.2]** <Insert value>.
 - I. Sprinkler Finishes: **[Chrome plated] [bronze] [and] [painted]**.
 - J. Special Coatings: **[Wax] [lead] [and] [corrosion-resistant paint]**.
 - K. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: **[Chrome-plated steel, one piece, flat] [Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment] [Plastic, white finish, one piece, flat]**.
 - 2. Sidewall Mounting: **[Chrome-plated steel] [Plastic, white finish]**, one piece, flat.
 - L. Sprinkler Guards and Water Shields:
 - 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - c. Victaulic Company.
 - d. Viking Group Inc.
 - e. **<Insert manufacturer's name>**.
 - 2. Standard: UL 199.
 - 3. Description: Wire cage with fastening device for attaching to sprinkler.
- 1.12 ALARM DEVICES
- A. Match alarm-device material and connection types to piping and equipment materials and connection types.

B. Water-Motor-Operated Alarm:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Victaulic Company.
 - c. Viking Group Inc.
 - d. **<Insert manufacturer's name>**.
2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: **[8-1/2-inch (216-mm)] [10-inch (250-mm)] [Insert diameter]** diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4 (DN 20).
8. Outlet: NPS 1 (DN 25) drain connection.

C. Electrically Operated Notification Appliances:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Notifier; Honeywell International, Inc.
 - b. Potter Electric Signal Company, LLC.
 - c. **<Insert manufacturer's name>**.
2. Electric Bell:
 - a. Standard: UL 464.
 - b. Type: Vibrating, metal alarm bell.
 - c. Size: **[6-inch (150-mm) minimum-] [8-inch (200-mm) minimum-] [10-inch (250-mm)]** diameter.
 - d. Voltage: **[120 V ac, 60 Hz, single phase] [24 V dc]**.
 - e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.
3. Strobe/Horn:
 - a. Standard: UL 464.
 - b. Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
 - c. Voltage: 120 V ac, 60 Hz.
 - d. Effective Intensity: 110 cd.
 - e. Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."
 - f. Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police or fire department.

D. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Potter Electric Signal Company, LLC.
 - b. System Sensor; Honeywell International, Inc.
 - c. Viking Group Inc.
 - d. **<Insert manufacturer's name>**.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125 V ac and 0.25 A, 24 V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

E. Pressure Switches - Water-Flow Alarm Detection:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Potter Electric Signal Company, LLC.
 - b. System Sensor; Honeywell International, Inc.
 - c. **<Insert manufacturer's name>**.
2. Description: Electrically supervised, pressure-activated water-flow switch with retard feature.
3. Components: Two single-pole, double-throw switches with normally closed contacts.
4. Design Operation: Rising pressure to **[6 psi (40 kPa), plus or minus 2 psi (13.8 kPa)] <Insert value>** signals water flow.
5. Adjustability: Each switch is to be independently adjustable.
6. Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.

F. Pressure Switches - Low/High Air Pressure Supervisory:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Potter Electric Signal Company, LLC.
 - b. System Sensor; Honeywell International, Inc.
 - c. **<Insert manufacturer's name>**.
2. Description: Electrically supervised pressure supervisory switch.
3. Components: Two single-pole, double-throw switches.
4. Design Operation: Detects increase and/or decrease from normal supervisory air pressure.
5. Adjustability: Each switch is to be independently adjustable.

6. Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.
- G. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Kennedy Valve Company; a division of McWane, Inc.
 - b. Potter Electric Signal Company, LLC.
 - c. System Sensor; Honeywell International, Inc.
 - d. **<Insert manufacturer's name>**.
 2. Standard: UL 346.
 3. Type: Electrically supervised.
 4. Design: Signals that controlled valve is in other than fully open position.
 5. Wire Terminal Designations: Indicates normal switch position when switch is properly installed on valve and valve is fully open.
 6. 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.
 7. OS&Y Valve Supervisory Switches:
 - a. One or two single-pole, double-throw switches.
 - b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
 - c. Visual Switch Indication: Indicates device is properly installed and OS&Y valve is fully open.
 - d. Mounting Hardware: Mounting bracket to grip valve yoke and prevent movement of switch assembly on OS&Y valve.
 - e. Trip Rod Length: Adjustable
 8. Butterfly Valve Supervisory Switches:
 - a. Two single-pole, double-throw switches.
 - b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
 - c. Mounting Hardware: Removable nipple.
 - d. Trip Rod Length: Adjustable
 9. Ball Valve Supervisory Switches:
 - a. One single-pole, double-throw switch.
 - b. NEMA Rating: NEMA 4 enclosure suitable for mounting in any position indoors or outdoors.
 - c. Mounting Hardware: Suitable for mounting directly to pipe, ball valves, or backflow preventers sized from up to NPS 2 (DN 50).
- H. Indicator-Post Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Potter Electric Signal Company, LLC.
 - b. System Sensor; Honeywell International, Inc.

c. <Insert manufacturer's name>.

2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

1.13 MANUAL CONTROL STATIONS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide"
- B. Description: For hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve.
- C. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

1.14 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
 1. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
 2. Electrical characteristics are 120 V ac, 60 Hz, with 24 V dc rechargeable batteries.
 3. 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. Manual Control Stations, Electric Operation: Metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- C. Manual Control Stations, Hydraulic Operation: Provide union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- D. Panel Components:
 1. Power supply.
 2. Battery charger.
 3. Standby batteries.
 4. Field-wiring terminal strip.
 5. Electrically supervised solenoid valves and polarized fire-alarm bell.
 6. Lamp test facility.
 7. Single-pole, double-throw auxiliary alarm contacts.
 8. Rectifier.

1.15 PRESSURE GAUGES

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 1. AGF Manufacturing, Inc.
 2. Ametek U.S. Gauge.
 3. Ashcroft Inc.
 4. Brecco Corporation.
 5. WIKA Instrument Corporation.
 6. <Insert manufacturer's name>.

- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- D. Pressure Gauge Range: **[0 to 250 psig (0 to 1725 kPa) minimum] [0 to 300 psig (0 to 2070 kPa)]**.
- E. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.
- F. Air System Piping Gauge: Include **[retard feature and]** "AIR" or "AIR/WATER" label on dial face.

PART 2 - PRODUCT – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION 211000

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SECTION 213113 - ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 – GENERAL – NOT USED

PART 2 - PRODUCTS

1.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Comply with NFPA 20.
- B. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
 - 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. Component Importance Factor: 1.5.
- C. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.
- 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.

1.2 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

- A. Description: Factory-assembled and -tested fire-pump and driver unit.
- B. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
- C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

1.3 END-SUCTION FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A-C Fire Pump; a Xylem brand.
 - 2. CPS Products, Inc.
 - 3. Patterson Pump Company; a Gorman-Rupp company.
 - 4. Peerless Pump Company.
 - 5. Reddy-Buffaloes Pump Company.
 - 6. S.A. Armstrong Limited.
 - 7. **<Insert manufacturer's name>.**
- B. Pump:
 - 1. Standard: [UL 448] **<Insert standard>**, for end-suction pumps for fire service.
 - 2. Casing: Radially split case, top centerline discharge, self-venting, cast iron, with ASME B16.1 pipe-flange connections.
 - 3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
 - 4. Wear Rings: Replaceable bronze.
 - 5. Shaft and Sleeve: Steel shaft with [bronze] [stainless-steel] sleeves.
 - a. Shaft Bearings: Grease-lubricated, back-to-back thrust ball bearings and one radial roller bearing.
 - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

6. Mounting: Back pullout design, allowing complete rotating assembly removal without disturbing the casing piping connections. Pump and driver shafts are horizontal, with pump and driver on same base.
- C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
- D. Driver:
 1. Standard: **[UL 1004A]** <Insert standard>.
 2. Type: Electric motor; NEMA MG 1, polyphase Design B.
- E. Capacities and Characteristics:
 1. Rated Capacity: <Insert gpm >.
 2. Total Rated Head: <Insert feet or psig >.
 3. Inlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 4. Outlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 5. Suction Head Available at Pump: <Insert feet >.
 6. Motor Horsepower: <Insert number> hp.
 7. Motor Speed: <Insert number> rpm.
 8. Electrical Characteristics:
 - a. Volts: **[208]** **[230]** **[460]** <Insert number> V.
 - b. Phase: Three.
 - c. Hertz: 60.
 - d. Full-Load Amperes: <Insert number> A.
 - e. Minimum Circuit Ampacity: <Insert number> A.
 - f. Maximum Overcurrent Protection: <Insert number> A.
 9. Pump-Start, Pressure-Switch Setting: <Insert psig >.
 10. Pump-Stop, Pressure-Switch Setting: <Insert psig >.

1.4 IN-LINE FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. A-C Fire Pump; a Xylem brand.
 2. CPS Products, Inc.
 3. Patterson Pump Company; a Gorman-Rupp company.
 4. Peerless Pump Company.
 5. Pentair Pump Group.
 6. Plad Equipment, Ltd.
 7. Reddy-Buffaloes Pump Company.
 8. S.A. Armstrong Limited.
 9. **<Insert manufacturer's name>.**
- B. Pump:
 1. Standard: **[UL 448]** <Insert standard>, for in-line pumps for fire service.
 2. Casing: Radially split case, cast iron, with ASME B16.1 pipe-flange connections.
 3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
 4. Wear Rings: Replaceable bronze.
 5. Shaft and Sleeve: Steel shaft with bronze sleeve.
 - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
 - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

6. Mounting: Pump and driver shaft is vertical, with motor above pump and pump on base. Motor and pump rotating assembly shall be removable from top without removing the pump casing from the piping.
 - C. Coupling: None or rigid.
 - D. Driver:
 1. Standard: **[UL 1004A]** <Insert standard>.
 2. Type: Electric motor; NEMA MG 1, polyphase Design B.
 - E. Capacities and Characteristics:
 1. Rated Capacity: <Insert gpm >.
 2. Total Rated Head: <Insert feet or psig >.
 3. Inlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 4. Outlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 5. Suction Head Available at Pump: <Insert feet >.
 6. Motor Horsepower: <Insert number> hp.
 7. Motor Speed: <Insert number> rpm.
 8. Electrical Characteristics:
 - a. Volts: **[208]** **[230]** **[460]** <Insert number> V.
 - b. Phase: Three.
 - c. Hertz: 60.
 - d. Full-Load Amperes: <Insert number> A.
 - e. Minimum Circuit Ampacity: <Insert number> A.
 - f. Maximum Overcurrent Protection: <Insert number> A.
 9. Pump-Start, Pressure-Switch Setting: <Insert psig >.
 10. Pump-Stop, Pressure-Switch Setting: <Insert psig >.
- 1.5 HORIZONTALLY MOUNTED, SINGLE-STAGE, SPLIT-CASE FIRE PUMPS
- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 1. A-C Fire Pump; a Xylem brand.
 2. CPS Products, Inc.
 3. PACO Pumps; Grundfos Pumps Corporation, USA.
 4. Patterson Pump Company; a Gorman-Rupp company.
 5. Peerless Pump Company.
 6. Pentair Pump Group.
 7. Reddy-Buffaloes Pump Company.
 8. Ruhrpumpen, Inc.
 9. S.A. Armstrong Limited.
 10. **<Insert manufacturer's name>.**
 - B. Pump:
 1. Standard: **[UL 448]** <Insert standard>, for split-case pumps for fire service.
 2. Casing: Axially split case, cast iron, with ASME B16.1 pipe-flange connections.
 3. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
 4. Wear Rings: Replaceable bronze.
 5. Shaft and Sleeve: Alloy steel shaft with bronze sleeve.
 - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.

- b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
 - 6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
- C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
- D. Driver:
 - 1. Standard: **[UL 1004A]** <Insert standard>.
 - 2. Type: Electric motor; NEMA MG 1, polyphase Design B.
- E. Capacities and Characteristics:
 - 1. Rated Capacity: <Insert gpm >.
 - 2. Total Rated Head: <Insert feet or psig >.
 - 3. Inlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 - 4. Outlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 - 5. Suction Head Available at Pump: <Insert feet >.
 - 6. Motor Horsepower: <Insert number> hp.
 - 7. Motor Speed: <Insert number> rpm.
 - 8. Electrical Characteristics:
 - a. Volts: **[208]** **[230]** **[460]** <Insert number> V.
 - b. Phase: Three.
 - c. Hertz: 60.
 - d. Full-Load Amperes: <Insert number> A.
 - e. Minimum Circuit Ampacity: <Insert number> A.
 - f. Maximum Overcurrent Protection: <Insert number> A.
 - 9. Pump-Start, Pressure-Switch Setting: <Insert psig >.
 - 10. Pump-Stop, Pressure-Switch Setting: <Insert psig >.
 - 11. Rotation **[Clockwise]** **[Counterclockwise]**.

1.6 HORIZONTALLY MOUNTED, MULTISTAGE, SPLIT-CASE FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A-C Fire Pump; a Xylem brand.
 - 2. Patterson Pump Company; a Gorman-Rupp company.
 - 3. Peerless Pump Company.
 - 4. Pentair Pump Group.
 - 5. Reddy-Buffaloes Pump Company.
 - 6. S.A. Armstrong Limited.
 - 7. **<Insert manufacturer's name>.**
- B. Pump:
 - 1. Standard: **[UL 448]** <Insert standard>, for split-case pumps for fire service.
 - 2. Number of Stages: Two.
 - 3. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
 - 4. Impeller: Single suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
 - 5. Wear Rings: Replaceable bronze.
 - 6. Shaft and Sleeve: Alloy steel shaft with bronze sleeve.
 - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.

- b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
- 7. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
- C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
- D. Driver:
 - 1. Standard: **[UL 1004A]** <Insert standard>.
 - 2. Type: Electric motor; NEMA MG 1, polyphase Design B.
- E. Capacities and Characteristics:
 - 1. Rated Capacity: <Insert gpm >.
 - 2. Total Rated Head: <Insert feet or psig >.
 - 3. Inlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 - 4. Outlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 - 5. Suction Head Available at Pump: <Insert feet >.
 - 6. Motor Horsepower: <Insert number> hp.
 - 7. Motor Speed: <Insert number> rpm.
 - 8. Electrical Characteristics:
 - a. Volts: **[208]** **[230]** **[460]** <Insert number> V.
 - b. Phase: Three.
 - c. Hertz: 60.
 - d. Full-Load Amperes: <Insert number> A.
 - e. Minimum Circuit Ampacity: <Insert number> A.
 - f. Maximum Overcurrent Protection: <Insert number> A.
 - 9. Pump-Start, Pressure-Switch Setting: <Insert psig >.
 - 10. Pump-Stop, Pressure-Switch Setting: <Insert psig >.

1.7 VERTICALLY MOUNTED, SINGLE-STAGE, SPLIT-CASE FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A-C Fire Pump; a Xylem brand.
 - 2. Patterson Pump Company; a Gorman-Rupp company.
 - 3. Peerless Pump Company.
 - 4. Pentair Pump Group.
 - 5. Reddy-Buffaloes Pump Company.
 - 6. <Insert manufacturer's name>.
- B. Pump:
 - 1. Standard: **[UL 448]** <Insert standard>, for split-case pumps for fire service.
 - 2. Casing: Axially split case, cast iron, with ASME B16.1 pipe-flange connections.
 - 3. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
 - 4. Wear Rings: Replaceable bronze.
 - 5. Shaft and Sleeve: Alloy steel shaft with bronze sleeve.
 - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
 - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
 - 6. Mounting: Pump and driver shafts are vertical, with motor above pump and pump on base.

- C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
- D. Driver:
 - 1. Standard: **[UL 1004A]** <Insert standard>.
 - 2. Type: Electric motor; NEMA MG 1, polyphase Design B.
- E. Capacities and Characteristics:
 - 1. Rated Capacity: <Insert gpm >.
 - 2. Total Rated Head: <Insert feet or psig >.
 - 3. Inlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 - 4. Outlet Flange: **[Class 125]** **[Class 250]** <Insert class>.
 - 5. Suction Head Available at Pump: <Insert feet >.
 - 6. Motor Horsepower: <Insert number> hp.
 - 7. Motor Speed: <Insert number> rpm.
 - 8. Electrical Characteristics:
 - a. Volts: **[208]** **[230]** **[460]** <Insert number> V.
 - b. Phase: Three.
 - c. Hertz: 60.
 - d. Full-Load Amperes: <Insert number> A.
 - e. Minimum Circuit Ampacity: <Insert number> A.
 - f. Maximum Overcurrent Protection: <Insert number> A.
 - 9. Pump-Start, Pressure-Switch Setting: <Insert psig >.
 - 10. Pump-Stop, Pressure-Switch Setting: <Insert psig >.

1.8 FIRE-PUMP ACCESSORIES AND SPECIALTIES

- A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
- B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.
- C. Relief Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BERMAD Control Valves.
 - b. CLA-VAL.
 - c. Kunkle Valve.
 - d. OCV Control Valves.
 - e. WATTS.
 - f. Zurn Industries, LLC.
 - 2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
- D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
- E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
- F. Discharge Cone: **[Closed]** **[Open]** **[Closed or open]** type.
- G. Hose Valve Manifold Assembly:
 - 1. Standard: Comply with requirements in NFPA 20.
 - 2. Header Pipe: ASTM A53/A53M, Schedule 40, galvanized steel, with ends threaded according to ASME B1.20.1.
 - 3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.

4. Automatic Drain Valve: UL 1726.
5. Manifold, Flush-Type Body:
 - a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
 - b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
 - c. Nipples: ASTM A53/A53M, Schedule 40, galvanized-steel pipe, with ends threaded according to ASME B1.20.1.
 - d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
 - e. Escutcheon Plate: Brass or bronze; rectangular.
 - f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
 - g. Exposed Parts Finish: [**Polished**] [**Rough**] [**brass**] [, **chrome plated**].
 - h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."
6. Manifold, Exposed-Type Body:
 - a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
 - b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
 - c. Escutcheon Plate: Brass or bronze; round.
 - d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
 - e. Exposed Parts Finish: [**Polished**] [**Rough**] [**brass**] [, **chrome plated**].
 - f. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

1.9 FLOWMETER SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Emerson Process Management; Rosemount Division.
 2. Fire Research Corp.
 3. Gerand Engineering Co.
 4. Hydro Flow Products, Inc.
 5. Hyspan Precision Products, Inc.
 6. Meriam Process Technologies.
 7. Preso Meters; Division of Racine Federated Inc.
 8. Reddy-Buffaloes Pump Company.
 9. Victaulic Company.
 10. **<Insert manufacturer's name>.**
- B. Description: UL-listed or FM-Approved, fire-pump flowmeter system able to indicate flow to not less than 175 percent of fire-pump rated capacity.
- C. Pressure Rating: [**175 psig minimum**] [**250 psig**].
- D. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
- E. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches () in diameter. Include bracket or device for wall mounting.
 1. Tubing Package: NPS 1/8 or NPS 1/4 [**soft copper**] [**or**] [**plastic**] tubing with copper or brass fittings and valves.
- F. Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches () in diameter and with two 12-foot- () long hoses in carrying case.

ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

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1.10 GROUT

- A. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

1.11 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
 - 1. Verification of Performance: Rate fire pumps according to UL 448.
- B. Fire pumps will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 2 - PRODUCT – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION 213113

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

Identification shall be specific for each system and/or equipment. Color code each individual system so that they are easily identified.

- A. All equipment shall allow space for digital tagging by District.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. emedco.
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: [**Brass, 0.032-inch 0.8-mm**] [**stainless steel, 0.025-inch 0.64-mm**] [**aluminum, 0.032-inch 0.8-mm**] [**anodized aluminum, 0.032-inch 0.8-mm**] minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch 64 by 19 mm.
5. Minimum Letter Size: 1/4 inch 6.4 mm for name of units if viewing distance is less than 24 inches 600 mm, 1/2 inch 13 mm for viewing distances of up to 72 inches 1830 mm, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. emedco.
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.

- i. Marking Services, Inc.
 - j. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **[1/16 inch 1.6 mm] [1/8 inch 3.2 mm] <Insert dimension>** thick, with predrilled holes for attachment hardware.
 3. Letter and Background Color: As indicated for specific application under Part 3.
 4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch 64 by 19 mm.
 6. Minimum Letter Size: 1/4 inch 6.4 mm for name of units if viewing distance is less than 24 inches 600 mm, 1/2 inch 13 mm for viewing distances of up to 72 inches 1830 mm, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Brimar Industries, Inc.
 3. Carlton Industries, LP.
 4. Champion America.
 5. Craftmark Pipe Markers.
 6. emedco.
 7. LEM Products Inc.
 8. Marking Services Inc.
 9. National Marker Company.
 10. Seton Identification Products; a Brady Corporation company.
 11. Stranco, Inc.
 12. **<Insert manufacturer's name>.**
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **[1/16 inch 1.6 mm] [1/8 inch 3.2 mm] <Insert dimension>** thick, with predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch 64 by 19 mm.
- F. Minimum Letter Size: 1/4 inch 6.4 mm for name of units if viewing distance is less than 24 inches 600 mm, 1/2 inch 13 mm for viewing distances of up to 72 inches 1830 mm, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E[, **and other applicable codes and standards**].
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Craftmark Pipe Markers.
 - 4. National Marker Company.
 - 5. Seton Identification Products; a Brady Corporation company.
- B. Material: Vinyl.
- C. Minimum Thickness: 0.005 inch (0.12 mm).
- D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
- F. Maximum Temperature: 160 deg F (70 deg C).
- G. Minimum Width: **[2 inches (50 mm)] [4 inches (100 mm)]**.

2.4 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP.
 - 5. Champion America.
 - 6. Craftmark Pipe Markers.
 - 7. emedco.
 - 8. Kolbi Pipe Marker Co.
 - 9. LEM Products Inc.
 - 10. Marking Services Inc.
 - 11. Seton Identification Products; a Brady Corporation company.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to **[partially cover] [cover full]** circumference of pipe and to attach to pipe without fasteners or adhesive.
- E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
 - 1. Pipe size.
 - 2. Flow-Direction Arrows: Include flow-direction arrows on[**main**] distribution piping. Arrows may be either integral with label or applied separately.

3. Lettering Size: **[Size letters in accordance with ASME A13.1 for piping] [At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances].**

2.5 STENCILS

A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brimar Industries, Inc.
 - b. Craftmark Pipe Markers.
 - c. Kolbi Pipe Marker Co.
 - d. Marking Services Inc.
2. Lettering Size: **[Size letters in accordance with ASME A13.1 for piping] [At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances].**
3. Stencil Material: Aluminum, brass, or fiberboard.
4. Stencil Paint: Exterior, gloss, **[alkyd enamel] [acrylic enamel] <Insert paint type>** in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, **[alkyd enamel] [acrylic enamel] <Insert paint type>** in colors in accordance with ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
6. Letter and Background Color: As indicated for specific application under Part 3.

2.6 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Services Inc.
11. Seton Identification Products; a Brady Corporation company.

B. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: **[Brass, 0.04-inch (1.0-mm)] [stainless steel, 0.024-inch (0.61-mm)] [aluminum, 0.031-inch (0.79-mm)] [or] [anodized aluminum, 0.031-inch (0.79-mm)]** minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass **[wire] [link chain] [or] [beaded chain] [or] [S-hook].**

C. Letter and Background Color: As indicated for specific application under Part 3.

- D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Brimar Industries, Inc.
 3. Champion America.
 4. Craftmark Pipe Markers.
 5. emedco.
 6. Kolbi Pipe Marker Co.
 7. LEM Products Inc.
 8. Marking Services Inc.
 9. Seton Identification Products; a Brady Corporation company.
- B. Description: Preprinted[**or partially preprinted**] accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: **[3 by 5-1/4 inches (75 by 133 mm) minimum] [Approximately 4 by 7 inches (100 by 178 mm)] <Insert size>.**
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION – NOT USED

END OF SECTION 220553

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SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

- A. Potable-water piping and components are to comply with NSF 14, NSF 61, and NSF 372. [**Include marking "NSF-pw" on piping.**]
- B. Provide each type of piping from a single manufacturer.

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

- A. Annealed-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**] [**ASTM B88, Type L (ASTM B88M, Type B)**]
- B. Drawn-Temper Copper Tube: [**ASTM B88, Type K (ASTM B88M, Type A)**] [**ASTM B88, Type L (ASTM B88M, Type B)**].
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- F. Cast 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. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- G. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- H. Copper-Tube, Mechanically Formed Tee Fitting - Domestic Water: For forming T-branch on copper water tube.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. T-DRILL Industries Inc.
 - b. **<Insert manufacturer's name>**.
 - 2. Description: Tee formed in copper tube in accordance with ASTM F2014.

I. Grooved, Mechanical-Joint, Copper Tube Appurtenances - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - b. Shurjoint; a part of Aalberts Integrated piping Systems.
 - c. Victaulic Company.
2. Source Limitations: Obtain grooved, mechanical-joint copper tube appurtenances from single manufacturer.
3. Grooved-End, Copper Fittings: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
4. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting, EPDM-rubber gasket, UL classified per NSF 61 and NSF 372, and rated for minimum **[180 deg F (80 deg C)] <Insert temperature>**, for use with ferrous housing and steel bolts and nuts; 300 psig (2060 kPa) minimum CWP pressure rating.

J. Pressure-Seal-Joint Fittings, Copper or Bronze - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. NIBCO INC.
 - c. Viega LLC.
2. Source Limitations: Obtain pressure-seal-joint fittings, copper or bronze, from single manufacturer.
3. Housing: Copper.
4. O-Rings and Pipe Stops: EPDM.
5. Tools: Manufacturer's special tools.
6. Minimum 200 psig (1370 kPa) working-pressure rating at 250 deg F (121 deg C).

K. Copper-Tube, Push-on-Joint Fittings - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems.
 - b. NIBCO INC.
2. Source Limitations: Obtain copper-tube, push-on-joint fittings from single manufacturer.
3. Description:
 - a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
 - b. Stainless steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.4 PIPING JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

- C. Solder Filler Metals: ASTM B32, lead-free alloys.
- D. Flux: ASTM B813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 ENCASEMENT FOR PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Form: **[Sheet]** **[or]** **[tube]**.
- C. Color: **[Black]** **[or]** **[natural]** **<Insert color>**.

2.6 TRANSITION FITTINGS - DOMESTIC WATER

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Couplings - Domestic Water: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Pipeline Solutions.
 - c. Ford Meter Box Company, Inc. (The).
 - d. Jay R. Smith Mfg Co; a division of Morris Group International.
 - e. JCM Industries, Inc.
 - f. Romac Industries, Inc.
 - g. Smith-Blair, a Xylem brand.
 - h. Viking Johnson.
 - 2. Source Limitations: Obtain sleeve-type transition couplings from single manufacturer.

2.7 DIELECTRIC FITTINGS - DOMESTIC WATER

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions - Domestic Water:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. HART Industrial Unions, LLC.
 - c. Jomar Valve.
 - d. Matco-Norca.
 - e. WATTS; A Watts Water Technologies Company.
 - f. Zurn Industries, LLC.
 - 2. Source Limitations: Obtain dielectric unions from single manufacturer.
 - 3. Standard: ASSE 1079.
 - 4. Pressure Rating: **[125 psig (860 kPa) minimum at 180 deg F (82 deg C)] [150 psig (1035 kPa)] [250 psig (1725 kPa)] <Insert value>**.

5. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. GF Piping Systems: Georg Fischer LLC.
 - c. Matco-Norca.
 - d. Zurn Industries, LLC.
 2. Source Limitations: Obtain dielectric flanges from single manufacturer.
 3. Standard: ASSE 1079.
 4. Factory-fabricated, bolted, companion-flange assembly.
 5. Pressure Rating: **[125 psig (860 kPa) minimum at 180 deg F (82 deg C)] [150 psig (1035 kPa)] [175 psig (1200 kPa)] [300 psig (2070 kPa)] <Insert value>.**
 6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. CALPICO, Inc.
 - c. GPT; a division of EnPRO Industries.
 2. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
 3. Nonconducting materials for field assembly of companion flanges.
 4. Pressure Rating: **[150 psig (1035 kPa)] <Insert value>.**
 5. Gasket: Phenolic, Temperature Rating: **[225 deg F (108 deg C)] <Insert temperature>.**
 6. Bolt Sleeves: Phenolic or polyethylene.
 7. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - b. Matco-Norca.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Victaulic Company.
 2. Source Limitations: Obtain dielectric nipples from single manufacturer.
 3. Standard: IAPMO PS 66.
 4. Electroplated steel nipple complying with ASTM F1545.
 5. Pressure Rating and Temperature: **[300 psig (2070 kPa) at 225 deg F (107 deg C)] <Insert values>.**
 6. End Connections: Male threaded or grooved.
 7. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION – NOT USED

END OF SECTION 221116

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following:**
1. Advanced Mechanical Technologies.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett; a Xylem brand.
 4. Grundfos Pumps Corp.
 5. TACO Incorporated.
 6. WILO USA LLC - WILO Canada Inc.
 7. **<Insert manufacturer's name>.**
- B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
- C. Pump Construction:
1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
 2. Casing: Bronze, with threaded or companion-flange connections.
 3. Impeller: Plastic.
 4. Motor: Single speed, unless otherwise indicated.
 5. Connection: Direct drive to the impeller.
- D. Capacities and Characteristics: Refer to schedule on drawings.

2.2 IN-LINE, WET ROTOR, CIRCULATING PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advanced Mechanical Technologies.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett; a Xylem brand.
 4. Grundfos Pumps Corp.
 5. TACO Incorporated.
 6. WILO USA LLC - WILO Canada Inc.
 7. **<Insert manufacturer's name>.**
- B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
- C. Pump Construction:
1. Pump and Motor Assembly: Hermetically sealed, wet-rotor lubricated type unit with motor and impeller on common shaft and designed for installation with pump and motor shaft mounted horizontally. Pump shall be minimally rated for 150 psig working pressure and 225 deg. F continuous water temperature.
 2. Casing: Bronze or stainless steel, with threaded or companion-flange connections.
 3. Impeller: Corrosion resistant material.

4. Motor: Single speed, unless otherwise indicated. Comply with requirements in Division 22 section "Common Motor Requirements for Plumbing Equipment."

D. Capacities and Characteristics: Refer to schedule on drawings.

2.3 HORIZONTALLY MOUNTED, IN-LINE, SEPARATELY COUPLED CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell & Gossett; a Xylem brand.
2. Marshall Engineered Products Co.
3. TACO Incorporated.
4. Thrush Co. Inc.
5. Weinman Division.
6. **<Insert manufacturer's name>.**

B. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.

C. Pump Construction:

1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
4. Coupling: Flexible.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
6. Bearings: Oil-lubricated; bronze-journal or ball type.
7. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

D. Motor: Single speed, with grease-lubricated ball bearings; and **[resiliently]** **[or]** **[rigidly]** mounted to pump casing.

E. Capacities and Characteristics: Refer to schedule on drawings.

2.4 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alyan Pump Company.
2. Armstrong Pumps, Inc.
3. Bell & Gossett; a Xylem brand.
4. Marshall Engineered Products Co.
5. PACO Pumps; Grundfos Pumps Corporation, USA.
6. Pentair Pump Group.
7. TACO Incorporated.
8. Thrush Co. Inc.
9. **<Insert manufacturer's name>.**

B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

C. Pump Construction:

1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
 2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
 3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
 4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
 5. Bearings: Oil-lubricated; bronze-journal or ball type.
 6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
- D. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.
- E. Capacities and Characteristics: Refer to schedule on drawings.

2.5 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alyan Pump Company.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett; a Xylem brand.
 4. Federal Pump Corp.
 5. Flo Fab inc.
 6. Grundfos Pumps Corp.
 7. Marshall Engineered Products Co.
 8. PACO Pumps; Grundfos Pumps Corporation, USA.
 9. Peerless Pump Company.
 10. Pentair Pump Group.
 11. TACO Incorporated.
 12. Thrush Co. Inc.
 13. Weinman Division.
 14. **<Insert manufacturer's name>.**
- B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections. **[Include pump manufacturer's base attachment for mounting pump on concrete base.]**
 2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
 3. Shaft and Shaft Sleeve: **[Stainless-steel or steel]** **[Stainless-steel]** shaft, with copper-alloy shaft sleeve.
 4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
 5. Bearings: Oil-lubricated; bronze-journal or ball type.
 6. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
- D. Motor: Single speed, with grease-lubricated ball bearings; rigidly mounted to pump casing.
- E. Capacities and Characteristics: Refer to schedule on drawings.

2.6 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.7 CONTROLS

- A. Pressure Switches: Electric, adjustable for control of **[water-supply]** **<Insert application>** pump.
1. Type: Water-immersion pressure sensor, for installation in piping.
 2. Enclosure: NEMA 250, **[Type 4X]** **<Insert type>**.
 3. Operation of Pump: On or off.
 4. Transformer: Provide if required.
 5. Power Requirement: **[24 V, ac]** **[120 V, ac]** **<Insert power>**.
 6. Settings: Start pump at **<Insert pressure>** and stop pump at **<Insert pressure>**.
- B. Thermostats: Electric; adjustable for control of **[hot-water circulation]** **<Insert application>** pump.
1. Type: Water-immersion temperature sensor, for installation in piping.
 2. Range: **[50 to 125 deg F (10 to 52 deg C)]** **[65 to 200 deg F (18 to 93 deg C)]** **[100 to 240 deg F (38 to 116 deg C)]** **<Insert range>**.
 3. Enclosure: NEMA 250, **[Type 4X]** **<Insert type>**.
 4. Operation of Pump: On or off.
 5. Transformer: Provide if required.
 6. Power Requirement: **[24 V, ac]** **[120 V, ac]** **<Insert power>**.
 7. Settings: Start pump at **[105 deg F (41 deg C)]** **[110 deg F (43 deg C)]** **[115 deg F (46 deg C)]** **<Insert temperature>** and stop pump at **[120 deg F (49 deg C)]** **[125 deg F (52 deg C)]** **<Insert temperature>**.
- C. Timers: Electric, for control of **[hot-water circulation]** **<Insert application>** pump.
1. Type: Programmable, **[seven-day]** **<Insert time>** clock with manual override on-off switch.
 2. Enclosure: NEMA 250, **[Type 1]** **<Insert type>**, suitable for wall mounting.
 3. Operation of Pump: On or off.
 4. Transformer: Provide if required.
 5. Power Requirement: **[24-V ac]** **[120-V ac]** **<Insert power>**.
 6. Programmable Sequence of Operation: **[Up to two on-off cycles each day for seven days]** **<Insert operational sequence>**.
 7. Features: Skip a day.
- D. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.
1. Type: Adjustable time-delay relay.
 2. Range: Up to five minutes.
 3. Setting: Five minutes.
 4. Enclosure: NEMA 250, **[Type 4X]** **<Insert type>**.
 5. Operation of Pump: On or off.
 6. Transformer: Provide if required.
 7. Power Requirement: **[24-V ac]** **[120-V ac]** **<Insert power>**.
 8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

PART 3 - EXECUTION – NOT USED

END OF SECTION 221123

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SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: **[10 ft. head of water (30 kPa head of water)] <Insert pressure>.**
 - 2. Waste, Force-Main Piping: **[50 psig (345 kPa)] [100 psig (690 kPa)] [150 psig (1035 kPa)] <Insert pressure>.**
- B. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7] <Insert requirement>**. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment":
 - 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. Component Importance Factor: **[1.5] [1.0]**.
- C. **<Insert requirements for Component Amplification Factor and Component Response Modification Factor>**.
- D. Coating Performance: Pipe and Fitting Coatings must pass the following performance specifications per EN 877:
 - 1. 350 hours of salt spray testing
 - 2. Resistance to wastewater for 30 days at 73° F
 - 3. Chemical resistance from pH 2 to pH 12 for 30 days at 73° F
 - 4. Resistance to hot water for 24 hours at 203° F

2.2 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. 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.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings:
 - 1. Marked with CISPI collective trademark.
 - 2. ASTM A888 or CISPI 301.

- C. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.
 - 1. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Conine Manufacturing Co., Inc.
 - b. SE Sovent.
- D. Heavy-Duty, Hubless-Piping Couplings:
 - 1. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. AB & I Foundry; a part of the McWane family of companies.
 - b. ANACO-Husky.
 - c. Charlotte Pipe and Foundry Company.
 - d. Clamp-All Corp.
 - e. Dallas Specialty & Mfg. Co.
 - f. Ideal Tridon Group.
 - g. MIFAB, Inc.
 - h. Mission Rubber Company, LLC; a division of MCP Industries.
 - i. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. **Standards:** ASTM C1277 and ASTM C1540. **<Insert standard>.**
 - 3. **Description:** Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.4 HIGH PERFORMANCE COATED HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS
([Above][Below] Grade)

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Tensile Strength: 21,000 psig minimum.
- C. Mark all cast iron soil pipe and fittings with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International.
 - 1. Mark each length of pipe and each fitting with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
- D. Ream the inside of each pipe prior to coating to decrease the coefficient of friction.
- E. Pipe Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an electrically deposited, high performance anodic epoxy top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
- F. Fitting Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an epoxy acrylic powder top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.

2.5 COPPER TUBE AND FITTINGS

- A. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
1. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 2. Cambridge-Lee Industries, LLC.
 3. Cerro Flow Products, LLC.
 4. Wieland Copper Products, LLC.
- B. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.
- C. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- D. Hard Copper Tube: ASTM B88, Type L and Type M (ASTM B88M, Type B and Type C), water tube, drawn temper.
- E. Soft Copper Tube: ASTM B88, Type L (ASTM B88M, Type B), water tube, annealed temper.
- F. Copper Pressure Fittings:
1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- G. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- H. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.6 PVC PIPE AND FITTINGS

- A. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
1. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 2. Charlotte Pipe and Foundry Company.
 3. GF Piping Systems.
 4. JM Eagle.
 5. National Pipe and Plastic, Inc.
 6. North America Pipe Corporation.
 7. Rocky Mountain Colby Pipe Company.
 8. Silver-line Plastics.
- B. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.
- C. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.
- D. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- E. Adhesive Primer: ASTM F656.
1. Adhesive primer shall have a VOC content of 550 g/L or less.

2. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

F. Solvent Cement: ASTM D2564.

1. Solvent cement shall have a VOC content of 510 g/L or less.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of 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 the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - 4) Plastic Oddities.
 - b. Standard: ASTM C1173.
 - 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. End Connections: Same size as and compatible with pipes to be joined.
 - e. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
 - 2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
 - 3) For Dissimilar Pipes: ASTM D5926 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 the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C1460.
 - 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.
 - d. End Connections: Same size as and compatible with pipes to be joined.
5. Pressure Transition Couplings:
 - a. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - 2) Cascade Waterworks Mfg. Co.
 - 3) EBAA Iron Sales, Inc.
 - 4) Ford Meter Box Company, Inc. (The).
 - 5) JCM Industries, Inc.
 - 6) Romac Industries, Inc.
 - b. Standard: AWWA C219.
 - c. Description: Metal sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - d. Center-Sleeve Material: **[Manufacturer's standard] [Carbon steel] [Stainless steel] [Ductile iron] [Malleable iron].**
 - e. Gasket Material: Natural or synthetic rubber.
 - f. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:
 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
 2. Dielectric Unions:
 - a. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) A.Y. McDonald Mfg. Co.
 - 2) Capitol Manufacturing Company.
 - 3) GF Piping Systems: Georg Fischer LLC.
 - 4) HART Industrial Unions, LLC.
 - 5) Jomar Valve.
 - 6) Matco-Norca.
 - 7) WATTS: A Watts Water Technologies Company.
 - 8) Wilkins.
 - 9) Zurn Industries, LLC.

- b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: **[125 psig (860 kPa) minimum at 180 deg F (82 deg C)] [150 psig (1035 kPa)] [250 psig (1725 kPa)] <Insert pressure>.**
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
- 3. Dielectric Flanges:
 - a. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Capitol Manufacturing Company.
 - 2) GF Piping Systems: Georg Fischer LLC.
 - 3) Matco-Norca.
 - 4) WATTS; A Watts Water Technologies Company.
 - 5) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: **[125 psig (860 kPa) minimum at 180 deg F (82 deg C)] [150 psig (1035 kPa)] [175 psig (1200 kPa)] [300 psig (2070 kPa)] <Insert pressure>.**
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- 4. Dielectric-Flange Insulating Kits:
 - a. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Advance Products & Systems, LLC.
 - 2) CALPICO, Inc.
 - 3) GF Piping Systems: Georg Fischer LLC.
 - 4) GPT; a division of EnPRO Industries.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure>.**
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.
- 5. Dielectric Nipples:
 - a. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Anvil; an ASC Engineered Solution.
 - 2) Elster Perfection; Honeywell.
 - 3) Matco-Norca.

- 4) Precision Plumbing Products.
- 5) Victaulic Company.

b. Description:

- 1) Standard: IAPMO PS 66.
- 2) Electroplated steel nipple.
- 3) Pressure Rating: **[300 psig (2070 kPa) at 225 deg F (107 deg C)] <Insert pressure and temperature>.**
- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

2.8 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A674 or AWWA C105/A 21.5.
- B. Material: **[Linear low-density polyethylene film of 0.008-inch (0.20-mm)] [or] [high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm)]** minimum thickness.
- C. Form: **[Sheet] [or] [tube]**.
- D. Color: **[Black] [or] [natural] <Insert color>.**

PART 3 - EXECUTION – NOT USED

END OF SECTION 221316

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SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves **<Insert drawing designation, if any>**:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - f. **<Insert manufacturer's name>**.
- 2. Standard: ASME A112.14.1.
- 3. Size: Same as connected piping.
- 4. Body: Cast iron.
- 5. Cover: Cast iron with **[bolted]** **[or]** **[threaded]** access check valve.
- 6. End Connections: **[Hub and spigot]** **[Hub and spigot or hubless]** **[Hubless]**.
- 7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang **[closed]** **[open for airflow unless subject to backflow condition]**.
- 8. Extension: ASTM A74, Service Class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

- B. Drain-Outlet Backwater Valves **<Insert drawing designation, if any>**:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 - e. **<Insert manufacturer's name>**.
- 2. Size: Same as floor drain outlet.
- 3. Body: Cast iron or bronze; made for vertical installation in bottom outlet of floor drain.
- 4. Check Valve: Removable ball float.
- 5. Inlet: Threaded.
- 6. Outlet: Threaded or spigot.

- C. Horizontal, Plastic Backwater Valves **<Insert drawing designation, if any>**:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Canplas LLC.

- b. IPS Corporation.
 - c. NDS Inc.
 - d. Oatey.
 - e. Plastic Oddities.
 - f. Sioux Chief Manufacturing Company, Inc.
 - g. Zurn Industries, LLC.
 - h. **<Insert manufacturer's name>.**
2. Size: Same as connected piping.
 3. Body: **[ABS] [PVC]**.
 4. Cover: Same material as body with threaded access to check valve.
 5. Check Valve: Removable swing check.
 6. End Connections: Socket type.

2.3 CLEANOUTS

- A. Provide cleanouts in piping where required by code as well as any change in direction where-ever/whenever accessible for ease of maintenance.
- B. Cast-Iron Exposed Cleanouts **<Insert drawing designation, if any>**:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Tyler Pipe; a subsidiary of McWane Inc.
 - e. WATTS.
 - f. Zurn Industries, LLC.
 - g. **<Insert manufacturer's name>.**
 2. Standard: ASME A112.36.2M.
 3. Size: Same as connected drainage piping
 4. Body Material: **[Hub-and-spigot, cast-iron soil pipe T-branch] [Hubless, cast-iron soil pipe test tee]** as required to match connected piping.
 5. Closure: **[Countersunk] [Countersunk or raised-head] [Raised-head], [brass] [cast-iron] [plastic]** plug.
 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- C. Stainless Steel Exposed Cleanouts:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BLÜCHER; A Watts brand.
 - b. Josam Company.
 - c. **<Insert manufacturer's name>.**
 2. Standard: ASME A112.3.1.
 3. Size: Same as connected drainage piping.
 4. Body Material: Stainless steel tee with side cleanout as required to match connected piping.
 5. Closure: Stainless steel plug with seal.
- D. Cast-Iron Exposed Floor Cleanouts **<Insert drawing designation, if any>**:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Sioux Chief Manufacturing Company, Inc.
 - e. WATTS.
 - f. Zurn Industries, LLC.
 - g. **<Insert manufacturer's name>.**
2. Standard: ASME A112.36.2M for **[adjustable housing] [cast-iron soil pipe with cast-iron ferrule] [heavy-duty, adjustable housing] [threaded, adjustable housing]** cleanout.
 3. Size: Same as connected branch.
 4. Type: **[Adjustable housing] [Cast-iron soil pipe with cast-iron ferrule] [Heavy-duty, adjustable housing] [Threaded, adjustable housing]**.
 5. Body or Ferrule: Cast iron.
 6. Clamping Device: **[Not required] [Required]**.
 7. Outlet Connection: **[Inside caulk] [Spigot] [Threaded]**.
 8. Closure: **[Brass plug with straight threads and gasket] [Brass plug with tapered threads] [Cast-iron plug] [Plastic plug]**.
 9. Adjustable Housing Material: **[Cast iron] [Plastic] <Insert material> with [threads] [setscrews or other device]**.
 10. Frame and Cover Material and Finish: **[Nickel-bronze, copper alloy] [Painted cast iron] [Polished bronze] [Rough bronze] [Stainless steel] <Insert material and finish>.**
 11. Frame and Cover Shape: **[Round] [Square] <Insert shape>.**
 12. Top-Loading Classification: **[Extra Heavy] [Heavy] [Light] [Medium]** Duty.
 13. Riser: ASTM A74, **[Extra-Heavy] [Service]** Class, cast-iron drainage pipe fitting and riser to cleanout.
- E. Stainless Steel Exposed Floor Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BLÜCHER; A Watts brand.
 - b. Josam Company.
 - c. Kusel Equipment Co.
 - d. Zurn Industries, LLC.
 - e. **<Insert manufacturer's name>.**
 2. Standards: ASME A112.3.1[; **NSF listed**].
 3. Size: Same as connected branch.
 4. Housing: **[Type 304 stainless steel] [Type 316 stainless steel]**.
 5. Closure: **[Stainless steel with seal] [Plastic plug]**.
 6. Riser: ASTM A74, **[Extra-Heavy] [Service]** Class, **[stainless steel] [cast-iron]** drainage pipe fitting and riser to cleanout.
 7. Body or Ferrule: Stainless steel.
 8. Clamping Device: **[Not required] [Required]**.
 9. Outlet Connection: **[Inside caulk] [Spigot] [Threaded] [Butt-weld]**.
 10. Adjustable Housing Material: **[Cast iron] [Plastic] <Insert material> with [threads] [setscrews or other device]**.
 11. Frame and Cover Material and Finish: Stainless steel.
 12. Frame and Cover Shape: **[Round] [Square] <Insert shape>.**
 13. Top-Loading Classification: **[Extra Heavy] [Heavy] [Light] [Medium]** Duty.
- F. Cast-Iron Wall Cleanouts **<Insert drawing designation, if any>:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - f. **<Insert manufacturer's name>.**
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: **[Hub-and-spigot, cast-iron soil pipe T-branch] [Hubless, cast-iron soil pipe test tee]** as required to match connected piping.
5. Closure Plug:
 - a. **[Brass] [Cast iron].**
 - b. **[Countersunk] [or] [raised]** head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access, Cover Plate: Round, **[deep, chrome-plated bronze] [flat, chrome-plated brass or stainless steel]** cover plate with screw.
7. Wall Access, Frame and Cover: **[Round] [Square], [nickel-bronze, copper-alloy, or stainless steel] <Insert material>** wall-installation frame and cover.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains **<Insert drawing designation, if any>**:
 1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
 2. Size: Same as connected waste piping **[with increaser fitting of size indicated].**
- B. Deep-Seal Traps **<Insert drawing designation, if any>**:
 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 (DN 50): 4-inch- (100-mm-) minimum water seal.
 - b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings **<Insert drawing designation, if any>**:
 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 (DN 15) side inlet.
- D. Floor-Drain, Inline Trap Seal **<Insert drawing designation, if any>**:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Rectorseal Plumbing; A CSW Industrials Company.
 - e. **<Insert manufacturer's name>.**

2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
 3. Material: Polymer.
 4. Standard: Tested and certified in accordance with ASSE 1072.
 5. Listing: **[ICC-ES] [or] [IAPMO]** listed.
 6. Size: Same as floor drain outlet or strainer throat.
- E. Air-Gap Fittings **<Insert drawing designation, if any>**:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 2. Body: Bronze or cast iron.
 3. Inlet: Opening in top of body.
 4. Outlet: Larger than inlet.
 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- F. Sleeve Flashing Device **<Insert drawing designation, if any>**:
1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend **[1 inch (25 mm)] [2 inches (51 mm)] <Insert dimension>** above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 2. Size: As required for close fit to riser or stack piping.
- G. Stack Flashing Fittings **<Insert drawing designation, if any>**:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 2. Size: Same as connected stack vent or vent stack.
- H. Vent Caps **<Insert drawing designation, if any>**:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
 2. Size: Same as connected stack vent or vent stack.
- I. Expansion Joints **<Insert drawing designation, if any>**:
1. Standard: ASME A112.6.4.
 2. Body: Cast iron with bronze sleeve, packing, and gland.
 3. End Connections: Matching connected piping.
 4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION – NOT USED

END OF SECTION 221319

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SECTION 221429 - SUMP PUMPS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of sump pump from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.3 SUMP PUMPS - SUBMERSIBLE

- A. Sump Pumps - Submersible, Fixed Position, Single Seal: **<Insert drawing designation>**.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Crane Pumps & Systems.
 - c. Glentronics, Inc.
 - d. Grundfos Pumps Corporation.
 - e. Industrial Flow Solutions.
 - f. Liberty Pumps.
 - g. Little Giant; a brand of Franklin Electric Co., Inc.
 - h. Pentair Aurora; Pentair Pump Group.
 - i. ProFlo; a Ferguson Enterprises, Inc. brand.
 - j. Weil Pump; a Wilo Company.
 - k. Xylem.
 - l. Zoeller Company.
2. Description: Factory-assembled and -tested sump-pump unit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
4. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, **[manufacturer's standard]** **<Insert material>** designed for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel[**or steel**], with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: **[Air] [Oil]**.
9. Capacities and Characteristics:
 - a. Unit Capacity: **<Insert gpm (L/min.)>**.
 - b. Number of Pumps: **[One] [Two] <Insert number>**.

- c. Each Pump:
 - 1) Capacity: <Insert gpm (L/min.)>.
 - 2) Total Dynamic Head: <Insert feetkPa>.
 - 3) Speed: <Insert rpm>.
 - 4) Discharge Size: <Insert NPS DN>.
 - 5) Electrical Characteristics:
 - a) Motor Horsepower: <Insert value> hp.
 - b) Volts: [120] [240] [277] [480] <Insert value> V ac.
 - c) Phases: [Single] [Three].
 - d) Hertz: 60.
 - d. Unit Electrical Characteristics:
 - 1) Full-Load Amperes: <Insert value> A.
 - 2) Minimum Circuit Ampacity: <Insert value> A.
 - 3) Maximum Overcurrent Protection: <Insert value> A.
10. Controls, Float- and Pressure-Switch Type:
- a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>; [pedestal] [wall] mounted.
 - b. Switch Type: [Mechanical-float] [Mercury-float] [Pressure] <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [mechanical-float, mercury-float, or pressure] <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
11. Control-Interface Features:
- a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
- B. Sump Pumps - Submersible, Fixed Position, Double Seal: <Insert drawing designation>.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. EBARA Pumps Americas Corp.
 - b. Grundfos Pumps Corporation.
 - c. Industrial Flow Solutions.
 - d. Xylem.
 - 2. Description: Factory-assembled and -tested sump-pump unit.
 - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
 - 4. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
 - 5. Impeller: Statically and dynamically balanced, [manufacturer's standard] <Insert material> designed for clear wastewater handling, and keyed and secured to shaft.
 - 6. Pump and Motor Shaft: Stainless steel[or steel], with factory-sealed, grease-lubricated ball bearings.
 - 7. Seals: Mechanical.

8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: **[Air] [Oil]**.
10. Unit Capacity: **<Insert gpmL/min.>**.
 - a. Number of Pumps: **[One] [Two] <Insert number>**.
 - b. Each Pump:
 - 1) Capacity: **<Insert gpm L/min.>**.
 - 2) Total Dynamic Head: **<Insert feet kPa>**.
 - 3) Speed: **<Insert rpm>**.
 - 4) Discharge Size: **<Insert NPSDN>**.
 - 5) Electrical Characteristics:
 - a) Motor Horsepower: **<Insert value> hp**.
 - b) Volts: **[120] [240] [277] [480] <Insert value> V ac**.
 - c) Phases: **[Single] [Three]**.
 - d) Hertz: 60.
 - c. Unit Electrical Characteristics:
 - 1) Full-Load Amperes: **<Insert value> A**.
 - 2) Minimum Circuit Ampacity: **<Insert value> A**.
 - 3) Maximum Overcurrent Protection: **<Insert value> A**.
11. Controls, Float- and Pressure-Switch Type:
 - a. Enclosure: NEMA 250, **[Type 1] [Type 4X] <Insert type>**; **[pedestal] [wall]** mounted.
 - b. Switch Type: **[Mechanical-float] [Mercury-float] [Pressure] <Insert type>** type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with **[mechanical-float, mercury-float, or pressure] <Insert type>** switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
12. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.

2.4 OIL-SENSING SUMP PUMPS AND CONTROLLERS

A. Oil-Sensing Sump Pumps and Controllers: **<Insert drawing designation>**.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Industrial Flow Solutions.
 - c. Liberty Pumps.
 - d. Little Giant; a brand of Franklin Electric Co., Inc.

- e. Weil Pump; a Wilo Company.
 - f. Xylem.
 - g. Zoeller Company.
 - h. **<Insert manufacturer's name>.**
- 2. Description: Factory-assembled and -tested sump-pump unit. ASME A17.1 compliant.
 - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
 - 4. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
 - 5. Unit Capacity: **<Insert gpm (L/min.)>.**
 - a. Number of Pumps: **[One] [Two] <Insert number>.**
 - b. Each Pump:
 - 1) Capacity: **<Insert gpm (L/min.)>.**
 - 2) Total Dynamic Head: **<Insert feet (kPa)>.**
 - 3) Speed: **<Insert rpm>.**
 - 4) Discharge Size: **<Insert NPS (DN)>.**
 - 5) Electrical Characteristics:
 - a) Motor Horsepower: **<Insert value> hp.**
 - b) Volts: **[120] [240] [277] [480] <Insert value> V ac.**
 - c) Phases: **[Single] [Three].**
 - d) Hertz: 60.
 - c. Unit Electrical Characteristics:
 - 1) Full-Load Amperes: **<Insert value> A.**
 - 2) Minimum Circuit Ampacity: **<Insert value> A.**
 - 3) Maximum Overcurrent Protection: **<Insert value> A.**
 - 6. Controls:
 - a. Industrial-grade switch(es) with internal **[20] <Insert number> A** relay and Type 304 stainless steel sensor probes.
 - b. Liquid/oil sensor that differentiates and indicates the presence of oil and/or water under high-water conditions.
 - c. Alarm Panel:
 - 1) High-oil-level alarm.
 - 2) High-water-level alarm.
 - 3) Audible and visual alarms for each alarm condition.
 - 4) Dry contacts for remote monitoring of oil, water, and high liquid conditions.
 - d. Control Panel:
 - 1) **[Simplex] [Duplex].**
 - 2) Enclosure: NEMA 250, Type 4X.
 - 3) HOA switch(es).
 - 4) Green pump run light; power on light.
 - 5) Pump circuit breaker(s).

2.5 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basins **<Insert drawing designation>**: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
 - 1. Material: **[Cast iron] [Fiberglass] [Polyethylene] <Insert material>.**
 - 2. Reinforcement: Mounting plates for pumps, fittings, and accessories.

3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, and in location and of size required to anchor basin in concrete slab.
- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
 1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.
- C. Capacities and Characteristics:
 1. Capacity: **<Insert gal. (L)>**.
 2. Diameter: **<Insert inches (mm)>**.
 3. Depth: **<Insert inches (mm)>**.
 4. Inlet No. 1:
 - a. Drainage Pipe Size: **<Insert NPS (DN)>**.
 - b. Bottom of Sump to Centerline: **<Insert inches (mm)>**.
 - c. Type: **[Flanged] [Hubbed] [Threaded]** outside.
 5. Inlet No. 2:
 - a. Drainage Pipe Size: **<Insert NPS (DN)>**.
 - b. Bottom of Sump to Centerline: **<Insert inches (mm)>**.
 - c. Type: **[Flanged] [Hubbed] [Threaded]** outside.
 6. Inlet No. 3:
 - a. Drainage Pipe Size: **<Insert NPS (DN)>**.
 - b. Bottom of Sump to Centerline: **<Insert inches (mm)>**.
 - c. Type: **[Flanged] [Hubbed] [Threaded]** outside.
 7. Sidewall Outlet:
 - a. Discharge Pipe Size: **<Insert NPS (DN)>**.
 - b. Bottom of Sump to Centerline: **<Insert inches (mm)>**.
 - c. Type: **[Hubbed inside] [Hubbed outside] <Insert type>**.
 8. Cover Material: **[Cast iron] [Steel with bituminous coating] [Cast iron or steel with bituminous coating] <Insert material>**.
 9. Cover Diameter: **<Insert inches (mm)>**, but not less than OD of basin top flange.
 10. Manhole Required in Cover: **[Yes] [No]**.
 11. Vent Size: **<Insert NPS (DN)>**.

2.6 PACKAGED DRAINAGE-PUMP UNITS - SUBMERSIBLE

- A. Packaged Drainage-Pump Units - Submersible: **<Insert drawing designation>**.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Liberty Pumps.
 - c. Little Giant; a brand of Franklin Electric Co., Inc.
 - d. Pentair Aurora; Pentair Pump Group .
 - e. Zoeller Company.
 - f. **<Insert manufacturer's name>**.
 2. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 14.1-14.2 and HI 14.3.
4. Casing: **[Metal]** <Insert material>.
5. Impeller: **[Brass]** <Insert material>.
6. Pump Seal: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
8. Power Cord: Three-conductor waterproof cable of length required, but not less than 72 inches (1830 mm), with grounding plug and cable-sealing assembly for connection at pump.
9. Pump Discharge Piping: Factory- or field-fabricated, **[galvanized, ASTM A53/A53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings]** <Insert pipe material>.
10. Control: Motor-mounted float switch.
11. Basin: Plastic.
12. Capacities and Characteristics:
 - a. Capacity: <Insert gpm (L/min.)>.
 - b. Total Dynamic Head: <Insert feet (kPa)>.
 - c. Speed: <Insert rpm>.
 - d. Discharge Pipe Size: <Insert NPS (DN)>.
 - e. Electrical Characteristics:
 - 1) Motor Horsepower: <Insert value> hp.
 - 2) Volts: **[120] [240] [277] [480]** <Insert value> V.
 - 3) Phases: **[Single] [Three]**.
 - 4) Hertz: 60.
 - 5) Full-Load Amperes: <Insert value> A.
 - 6) Minimum Circuit Ampacity: <Insert value> A.
 - 7) Maximum Overcurrent Protection: <Insert value> A.
 - f. Basin:
 - 1) Capacity: **[2 gal. (7.6 L)] [5 gal. (18.9 L)]** <Insert value> minimum.
 - 2) Inlet Connection: **[NPS 1-1/2 (DN 40)]** <Insert pipe size> minimum.

2.7 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Motors for submersible pumps are to be hermetically sealed.

PART 3 - EXECUTION – NOT USED

END OF SECTION 221429

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Seismic Performance: Commercial, electric, domestic-water heaters to withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7] <Insert requirement>**.
 - 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. Component Importance Factor: **[1.5] [1.0]**.
 - 3. **<Insert requirements for Component Amplification Factor and Component Response Modification Factor>**.
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- D. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Electric, Domestic-Water Booster Heaters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. Coates Heater Company, Inc.
 - c. Electric Heater Company (The).
 - d. Hatco Corporation.
 - e. HESco Industries, Inc.
 - f. Lochinvar, LLC.
 - g. **<Insert manufacturer's name>**.
 - 2. Source Limitations: Obtain domestic-water booster heaters from single source from single manufacturer.
 - 3. Standard: UL 1453.
 - 4. Tank Construction: **[Corrosion-resistant metal] [or] [steel]**.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig (1035 kPa).
 - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
 - 5. Factory-Installed Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - c. Insulation: Comply with ASHRAE/IES 90.1.

- d. Jacket: Rectangular shaped, with stainless steel front panel, unless otherwise indicated.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - 1) Option: Booster heaters with total of 9 kW or less may have one, two, or three elements.
 - f. Temperature Control: Adjustable thermostat, to setting of at least 180 deg F (82 deg C).
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
 - i. Gauges: Combination temperature-and-pressure type or separate thermometer and pressure gauge.
6. Special Requirements: NSF 5 construction with **[brackets for undercounter]** **[legs for floor]** installation.
- B. Commercial, Electric, Storage, Domestic-Water Heaters:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. American Water Heaters.
 - c. Bradford White Corporation.
 - d. Cemline Corporation.
 - e. Chronomite Laboratories, Inc; a division of Morris Group International.
 - f. Electric Heater Company (The).
 - g. HESco Industries, Inc.
 - h. Lochinvar, LLC.
 - i. Precision Boilers.
 - j. PVI; A WATTS Brand.
 - k. State Industries.
 - l. Vaughn Thermal Corporation.
 - m. **<Insert manufacturer's name>.**
 - 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 - 3. Standard: UL 1453.
 - 4. Storage-Tank Construction: **[Non-]**ASME-code, steel **[horizontal]** **[vertical]** arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
 - 2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: **[150 psig (1035 kPa)]** **<Insert value>.**
 - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

5. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - c. Insulation: Comply with ASHRAE/IES 90.1.
 - d. Jacket: Steel with enameled finish or high-impact composite material.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.
 6. Special Requirements: NSF 5 construction.
- C. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. American Water Heaters.
 - c. Bradford White Corporation.
 - d. Electric Heater Company (The).
 - e. Heat Transfer Products, Inc.
 - f. Lochinvar, LLC.
 - g. State Industries.
 - h. **<Insert manufacturer's name>.**
 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 3. Standard: UL 174.
 4. Storage-Tank Construction: Steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig (1035 kPa).
 - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
 5. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - d. Insulation: Comply with ASHRAE/IES 90.1.
 - e. Jacket: Steel with enameled finish or high-impact composite material.
 - f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Electric, screw-in immersion type.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
 6. Special Requirements: NSF 5 construction with legs for off-floor installation.

D. Capacity and Characteristics:

1. Capacity: Refer to schedule on drawings.
2. Recovery: **<Insert gph (L/s)>** at **[40 deg F (22 deg C)] [50 deg F (28 deg C)] [100 deg F (56 deg C)]** **<Insert temperature>** temperature rise.
3. Temperature Setting: **[125 deg F (52 deg C)] [140 deg F (60 deg C)] [180 deg F (82 deg C)]** **<Insert temperature>**.
4. Heating Elements:
 - a. Number of Elements: **[Two] [Three] [Six] [Nine]** **<Insert number>**.
 - b. Kilowatts Each Element: **<Insert kilowatts>**.
 - c. Number of Stages: **[One] [Two] [Three] [Four]** **<Insert number>**.
5. Electrical Characteristics: Refer to schedule on drawings.

2.3 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Flow-Control, Electric, Tankless, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bosch Thermotechnology Corp.
 - b. Bradley Corporation.
 - c. Chronomite Laboratories, Inc; a division of Morris Group International.
 - d. Eemax, Inc.; a Rheem brand.
 - e. Stiebel Eltron, Inc.
 - f. **<Insert manufacturer's name>**.
2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: UL 499 for electric, tankless, (domestic-water-heater) heating appliances.
4. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: **[150 psig (1035 kPa)]** **<Insert value>**.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Flow-control fitting.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
5. Support: Bracket for wall mounting.
6. Capacity and Characteristics:
 - a. Flow Rate: **<Insert gpm (L/s)>**.
 - b. Maximum Temperature Setting: **<Insert temperature>**.
 - c. Electrical Characteristics: Refer to schedule on drawings.

B. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bosch Thermotechnology Corp.
 - b. Bradley Corporation.
 - c. Chronomite Laboratories, Inc; a division of Morris Group International.
 - d. Eemax, Inc.; a Rheem brand.
 - e. Niagara Industries, Inc.
 - f. Stiebel Eltron, Inc.

- g. **<Insert manufacturer's name>.**
- 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
- 3. Standard: UL 499 for electric, tankless, (domestic-water-heater) heating appliances.
- 4. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: **[150 psig (1035 kPa)] <Insert value>.**
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Thermostat.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
- 5. Support: Bracket for wall mounting.
- 6. Capacity and Characteristics:
 - a. Flow Rate: **<Insert gpm (L/s)> at [100 deg F (56 deg C)] <Insert temperature> temperature rise.**
 - b. Temperature Setting: **[125 deg F (52 deg C)] [140 deg F (60 deg C)] <Insert temperature>.**
 - c. Electrical Characteristics: Refer to schedule on drawings.

2.4 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. AMTROL, Inc.
 - c. Flexcon Industries.
 - d. Honeywell International Inc.
 - e. Pentair Aurora; Pentair Pump Group.
 - f. ProFlo; a Ferguson Enterprises, Inc. brand.
 - g. State Industries.
 - h. Taco Comfort Solutions.
 - i. **<Insert manufacturer's name>.**
- 2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
- 3. 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.
- 4. 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 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.

5. Capacity and Characteristics:
 - a. Working-Pressure Rating: [100 psig (690 kPa)] [150 psig (1035 kPa)] <Insert value>.
 - b. Capacity Acceptable: [2 gal. (7.6 L)] [4 gal. (15.1 L)] [7 gal. (26.5 L)] [10 gal. (37.9 L)] <Insert value> minimum.
 - c. Air Precharge Pressure: <Insert system pressure>.
 - B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads.
 - C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with [ASHRAE/IES 90.1] [ASHRAE 90.2].
 - D. Heat-Trap Fittings: [ASHRAE/IES 90.1] [ASHRAE 90.2].
 - E. Manifold Kits: Domestic-water-heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and [calibrated] [memory-stop] balancing valves to provide balanced flow through each domestic-water heater.
 1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
 2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
 - F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- (172.5-kPa-) maximum outlet pressure unless otherwise indicated.
 - G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
 - H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.
 - I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
 - J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
 - K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of [18 inches (457 mm)] <Insert dimension> above the floor.
 - L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.
- 2.5 SOURCE QUALITY CONTROL
- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
 - B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
 - C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
 - D. Prepare test and inspection reports.

PART 3 - EXECUTION – NOT USED

END OF SECTION 223300

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Lavatory faucets, sink faucets, shower valves, and wash fountain spray heads and faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 COMMERCIAL LAVATORIES

A. Lavatories, Counter Mounted:

1. Lavatories, Undercounter Mounted - Enameled Cast Iron:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Kohler.
 - 2) Commercial Enameling Company.
 - 3) **<Insert manufacturer's name>**.
- b. Fixture:
 - 1) Standard: ASME A112.19.1/CSA B45.2.
 - 2) Type: For undercounter mounting.
 - 3) Faucet-Hole Location: On countertop.
 - 4) Mounting Materials: Sealant and undercounter mounting kit.

2. Lavatories, Undercounter Mounted - Vitreous China, Oval:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) Sloan Valve Company.
 - 4) TOTO USA, INC.
 - 5) Zurn Industries, LLC.
 - 6) **<Insert manufacturer's name>**.
- b. Fixture:
 - 1) Standard: ASME A112.19.2/CSA B45.1.
 - 2) Type: For undercounter mounting.
 - 3) Faucet-Hole Location: On countertop.
 - 4) Mounting Material: Sealant and undercounter mounting kit.

B. Lavatories, Wall Mounted:

1. Lavatory, Wall Mounted - Enameled Cast Iron, Rectangular:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) Zurn Industries, LLC.
 - 4) **<Insert manufacturer's name>**.
 - b. Fixture:
 - 1) Standard: ASME A112.19.1/CSA B45.2.
 - 2) Type: Straight-front apron with straight back.
 - 3) Faucet-Hole Location: Top.
 - 4) Mounting Material: Wall bracket.
 - c. Support: **[Lavatory carrier, framing affixed] [Lavatory carrier, floor affixed with steel uprights] <Insert carrier>**.
2. Lavatories, Wall Mounted - Vitreous China, Rectangular with Back:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) Sloan Valve Company.
 - 4) Zurn Industries, LLC.
 - 5) **<Insert manufacturer's name>**.
 - b. Fixture:
 - 1) Standard: ASME A112.19.2/CSA B45.1.
 - 2) Type: For wall hanging.
 - 3) Faucet-Hole Location: Top.
 - 4) Mounting Material: Chair carrier.
 - c. Support: **[Lavatory carrier, framing affixed] [Lavatory carrier, floor affixed with steel uprights] [,] [exposed arm] [concealed arm] <Insert carrier>**.
3. Lavatories, Wall Mounted - Vitreous China, Rectangular with Ledge Back:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) Sloan Valve Company.
 - 4) **<Insert manufacturer's name>**.
 - b. Fixture:
 - 1) Standard: ASME A112.19.2/CSA B45.1.
 - 2) Type: For wall hanging.
 - 3) Faucet-Hole Location: Top.
 - 4) Mounting Material: Chair carrier.
 - c. Support: **[Lavatory carrier, framing affixed] [Lavatory carrier, floor affixed with steel uprights] [,] [exposed arm] [concealed arm] <Insert carrier>**.
4. Lavatories, Wall Mounted - Vitreous China, Rectangular, Wheelchair:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) Zurn Industries, LLC.
 - 4) **<Insert manufacturer's name>.**
 - b. Fixture:
 - 1) Standard: ASME A112.19.2/CSA B45.1.
 - 2) Type: Wheelchair.
 - 3) Faucet-Hole Location: Top.
 - 4) Mounting: For concealed-arm carrier.
 - c. Support: **[Lavatory carrier, floor affixed with steel uprights] [,] [exposed-arm] [concealed-arm] <Insert carrier>.**
5. Lavatories, Wall Mounted - Vitreous China, Corner Type:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) **<Insert manufacturer's name>.**
 - b. Fixture:
 - 1) Standard: ASME A112.19.2/CSA B45.1.
 - 2) Type: Three-sided-front apron with three-sided back.
 - 3) Faucet-Hole Location: Back wall.
 - 4) Mounting Materials: Wall brackets.
 - c. Faucet: Manufacturer's standard; factory installed.
 - d. Support: **[Lavatory carrier, framing affixed] [Lavatory carrier, floor affixed with steel uprights] <Insert carrier>.**

C. Lavatory Systems:

1. Lavatory Systems - Single or Multiple Stations:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Acorn Engineering Company; a Division of Morris Group International.
 - 2) Bradley Corporation.
 - 3) Sloan Valve Company.
 - 4) Willoughby Industries, Inc.
 - 5) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain lavatory systems from single source from single manufacturer.
 - c. Standards:
 - 1) ASME A112.18.1/CSA B125.1.
 - 2) CSA B45.5/IAPMO Z124.
 - 3) NSF 61.
 - 4) NSF 372.
 - 5) UPC, IPC, and GREENGUARD Certified.

- 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. Bowl(s) and Counter:
 - 1) Material: Solid-surface or natural quartz surface.
 - 2) Height to Rim: **[Standard] [Accessible in accordance with ICC A117.1] <Insert height>**.
 - 3) Access Panel: 16-1/8-inch (410-mm) access panel.
 - 4) Number of Bowls or User Stations: **[One] [Two] [Three] [Four] <Insert number>**.
 - 5) Bowl Shape: **[Trough] [Oval] [Round] [Square] [Rectangular] <Insert shape>**.
 - 6) Drain: Grid with NPS 1-1/2 (DN 40) tailpiece, each bowl.
- f. Pedestal: **[Not required] [Required, with access panel]**.
- g. Faucets:
 - 1) Type: Manufacturer's standard, chrome-plated solid brass, each bowl/station.
 - 2) Control: **[Manual, push-button] [Hardwired, control-voltage, sensor-actuated] [Battery-powered, sensor-actuated] <Insert type>** actuation with **[pressure-balancing] [thermostatic]** mixing valve with check stops for each bowl or user station.
- h. Mixer Point-of-Use:
 - 1) Material: Solid bimetal (bronze, brass, stainless steel).
 - 2) Security: Hot limit stop set to a maximum of 109.4 deg F (43 deg C).
 - 3) Set: Screwdriver adjustment temperature dial with scale: Cold-hot.
 - 4) Operation: Electronic "no-touch" hardwired powered.
 - 5) Power: 120 V ac.
- i. High-Speed, Warm-Air Hand Dryer:
 - 1) Dryer Mounting: **[Surface mounted][, with low-profile design]**.
 - 2) Operation: Electronic-sensor activated with operation time of **[10 to 20] <Insert number(s)>** seconds.
 - 3) Cover Material and Finish: **[Chrome-plated steel] <Insert material and finish>**.
 - 4) Electrical Requirements: **[115 V, 13 A, 1500 W] [115 V, 15 A, 1725 W] [115 V, 20 A, 2300 W] [208-240 V, 9-10 A, 1900-2300 W] <Insert electrical requirements>**.
- j. Liquid-Soap Dispensers: **[Hardwired, sensor actuated] [Battery powered, sensor actuated] [Not required]**, for each bowl or user station.
- k. Mounting: **[Manufacturer's wall-mounting bracket] [and/or] [commercial floor-mounted carrier] <Insert type>**.
- l. Supply Fittings:
 - 1) Piping: NPS 1/2 (DN 15) copper tubing, each bowl.
 - 2) Valves: Shutoff valve on each supply.
 - 3) Supply Piping: From wall.
- m. Waste Fittings:
 - 1) Standard: ASME A112.18.2/CSA B125.2.
 - 2) Trap and Drain Piping: NPS 1-1/2 (DN 40), each bowl.

D. Lavatory Faucets, Manually Operated:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Chicago Faucets; Geberit Group.
 - 3) Delta Faucet Company.
 - 4) Zurn Industries, LLC.
 - 5) **<Insert manufacturer's name>.**
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. Operation Type: **[Single control, mixing] [Single control, nonmixing] [Two handle, mixing], [Commercial] [General duty].**
 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 5. Body Type: **[Centerset] [Widespread] [Single hole] <Insert type>.**
 6. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
 7. Finish: **[Polished chrome plate] <Insert finish>.**
 8. Maximum Flow Rate: **[0.5 gpm (1.9 L/min.)] <Insert value>.**
 9. Maximum Flow: **[0.25 gal. (0.95 L)] <Insert value> per metering cycle.**
 10. Mounting Type: **[Deck, exposed] [Deck, concealed] [Back/wall, exposed] [Back/wall, concealed].**
 11. Valve Handle(s): **[Single lever] [Knob] [Knob, nonmetallic] [Cross, three arm] [Cross, four arm] [Wrist blade, 4 inches (102 mm)] [Elbow, 6 inches (150 mm)] [Push button] <Insert type>.**
 12. Spout: **[Rigid] [Swing] [Rigid, gooseneck] [Swivel, gooseneck] type.**
 13. Spout Outlet: **[Aerator] [Laminar flow] [Spray] <Insert type>.**
 14. Operation: **[Compression, manual] [Noncompression, manual].**
 15. Drain: **[Not part of faucet] <Insert type>.**
- E. Lavatory Faucets, Automatically Operated:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advanced Modern Technologies Corporation - AMTC.
 - 2) American Standard.
 - 3) Chicago Faucets; Geberit Group.
 - 4) T&S Brass and Bronze Works, Inc.
 - 5) Zurn Industries, LLC.
 - 6) **<Insert manufacturer's name>.**
 2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
 3. Operation Type: **[Battery powered] [Hardwired] electronic sensor operated, [mixing] [nonmixing].**
 4. 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.
 5. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 6. Body Type: **[Single hole] <Insert type>.**
 7. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
 8. Finish: **[Polished chrome plate] <Insert finish>.**
 9. Maximum Flow Rate: **[0.5 gpm (1.9 L/min.)] <Insert value>.**
 10. Mounting Type: **[Deck, concealed] [Back/wall, concealed] <Insert type>.**
 11. Spout: **[Rigid] [Swing] [Rigid, gooseneck] [Swivel, gooseneck] type.**

12. Spout Outlet: **[Aerator] [Laminar flow] [Spray] <Insert type>**.
13. Drain: **[Not part of faucet] <Insert type>**.

F. Lavatory Supply Fittings:

1. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
2. Standard: ASME A112.18.1/CSA B125.1.
3. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.
4. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
5. Operation: **[Loose key] [Wheel handle] <Insert type>**.
6. Risers:
 - a. **[NPS 3/8 (DN 10)] [NPS 1/2 (DN 15)]**.
 - b. **[Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces] [Chrome-plated, soft-copper flexible tube] [ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel, flexible hose] riser.**

G. Lavatory Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with NPS 1-1/4 (DN 32) offset and straight tailpiece.
3. Trap:
 - a. Size: **[NPS 1-1/2 by NPS 1-1/4 (DN 40 by DN 32)] [NPS 1-1/4 (DN 32)]**.
 - b. Material:
 - 1) Chrome-plated, **[two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall] [two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall] [one-piece, cast-brass trap with swivel 0.029-inch- (0.73-mm-) thick tubular brass wall bend] <Insert trap type>**; and chrome-plated, brass or steel wall flange.
 - 2) Stainless steel, two-piece trap and swivel elbow with 0.012-inch (0.30-mm-) thick stainless steel tube to wall, and stainless steel wall flange.

2.3 COMMERCIAL SHOWERS

A. Shower Valve Assemblies:

1. Shower Valve Assemblies - Single-Handle, Pressure-Balanced Mixing Valve with Head:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Chicago Faucets; Geberit Group.
 - 3) Kohler Co.
 - 4) Moen Incorporated.
 - 5) Symmons Industries, Inc.
 - 6) Zurn Industries, LLC.
 - 7) **<Insert manufacturer's name>**.
 - b. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.

- c. Description: Single-handle, [**accessible**,]pressure-balance mixing valve with hot- and cold-water indicators; [**diverting valve**] check stops; and [**hose with handheld shower head**] [**hose with handheld shower head on sliding rod**] shower head.
 - d. Shower Valve:
 - 1) Standards:
 - a) ASME A112.18.1/CSA B125.1.
 - b) ASSE 1016/ASME A112.1016/CSA B125.16.
 - 2) Body Material: Solid brass.
 - 3) Finish: [**Polished chrome plate**] <Insert finish>.
 - 4) Mounting: [**Concealed**] [**Exposed**].
 - 5) Operation: Single-handle, [**push-pull**] [**or**] [**twist or rotate**] [**or**] [**metering**] control.
 - 6) Antiscald Device: [**Integral with mixing valve**] [**Separate unit**] [**Not required**].
 - 7) Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
 - e. Supply Connections: NPS 1/2 (DN 15).
 - f. Shower Head:
 - 1) Standard: ASME A112.18.1/CSA B125.1.
 - 2) EPA WaterSense: Required.
 - 3) Shower Head Material: Metallic with chrome-plated finish.
 - 4) Spray Pattern: [**Adjustable**] [**Fixed**].
 - 5) Integral Volume Control: [**Not required**] [**Required**].
 - 6) Temperature Indicator: [**Integral with shower valve**] [**Not required**].
2. Shower Valve Assemblies - Single-Handle, Thermostatic Mixing Valve with Head:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Lawler Manufacturing Company, Inc.
 - 2) <Insert manufacturer's name>.
 - b. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.
 - c. Description: Single-handle, [**accessible**,]thermostatic mixing valve with hot- and cold-water indicators; [**diverting valve**] check stops; and [**hose with handheld shower head**] [**hose with handheld shower head on sliding rod**] shower head.
 - d. Shower Valve:
 - 1) Standards:
 - a) ASME A112.18.1/CSA B125.1.
 - b) ASSE 1016/ASME A112.1016/CSA B125.16.
 - 2) Body Material: Solid brass.
 - 3) Antiscald Device: [**Integral with mixing valve**] [**Separate unit**] [**Not required**].
 - 4) Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
 - e. Supply Connections: NPS 1/2 (DN 15).
 - f. Shower Head:
 - 1) Standard: ASME A112.18.1/CSA B125.1.

- 2) EPA WaterSense: Required.
3. Shower Valve Assemblies - Single-Handle, Thermostatic/Pressure-Balancing Mixing Valve with Head:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Chicago Faucets; Geberit Group.
 - 2) Lawler Manufacturing Company, Inc.
 - 3)
 - 4) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.
 - c. Description: Single-handle, **[accessible,]**thermostatic/pressure-balancing mixing valve with hot- and cold-water indicators; **[diverting valve]**check stops; and **[hose with handheld shower head] [hose with handheld shower head on sliding rod]**shower head.
 - d. Shower Valve:
 - 1) Standards:
 - a) ASME A112.18.1/CSA B125.1.
 - b) ASSE 1016/ASME A112.1016/CSA B125.16.
 - 2) Body Material: Solid brass.
 - 3) Finish: **[Polished chrome plate] <Insert finish>.**
 - 4) Mounting: **[Concealed] [Exposed].**
 - 5) Operation: Single-handle, **[push-pull] [or] [twist or rotate]** control.
 - 6) Antiscald Device: **[Integral with mixing valve] [Separate unit] [Not required].**
 - 7) Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
 - e. Supply Connections: NPS 1/2 (DN 15).
 - f. Shower Head:
 - 1) Standard: ASME A112.18.1/CSA B125.1.
 - 2) Type: **[Ball joint with arm and flange] [Without ball joint, but with arm and flange] [Ball joint and head integral with mounting flange] [Integral with mounting flange] <Insert type>.**
 - 3) EPA WaterSense: Required.
 - 4) Shower Head Maximum Flow Rate: **[1.5 gpm (5.7 L/min.)] [1.75 gpm (6.6 L/min.)] [2.0 gpm (7.6 L/min.)] [2.5 gpm (9.5 L/min.)].**
 - 5) Shower Head Material: Metallic with chrome-plated finish.
 - 6) Spray Pattern: **[Adjustable] [Fixed].**
 - 7) Integral Volume Control: **[Not required] [Required].**
 - 8) Temperature Indicator: **[Integral with valve] [Not required].**
 - g. EPA WaterSense: Required.
 - h. Internal Piping: Factory installed.
 - i. Mounting: Base flange with bolt holes.
- B. Grout:
 1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 2. Characteristics: Nonshrink; recommended for interior and exterior applications.
 3. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.

4. Packaging: Premixed and factory packaged.

2.4 COMMERCIAL SINKS

A. Service Sinks, Floor Mounted:

1. Service Sinks, Floor Mounted - Terrazzo:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Acorn Engineering Company; a Division of Morris Group International.
 - 2) Fiat Products.
 - 3) Florestone Products Co., Inc.
 - 4) Stern-Williams Products, LLC.
 - 5) **<Insert manufacturer's name>.**
- b. Source Limitations: Obtain sinks from single source from single manufacturer.
- c. Fixture:
 - 1) Material: Marble chips cast in portland cement to produce a compressive strength of not less than 3000 psi (20.7 MPa), seven days after casting.
 - 2) Tiling Flange: **[Not required] [On one side] [On two sides] [On three sides].**
 - 3) Rim Guard: On **[front] [all]** top surfaces.
 - 4) Drain: Grid with **[NPS 2 (DN 50)] [NPS 3 (DN 80)]** outlet.
- d. Mounting: On floor and flush to wall.

2. Service Sinks, Floor Mounted - Plastic:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) ProFlo; a Ferguson Enterprises, Inc. brand.
 - 2) Zurn Industries, LLC.
 - 3) **<Insert manufacturer's name>.**
- b. Source Limitations: Obtain sinks from single source from single manufacturer.
- c. Fixture:
 - 1) Standard: CSA B45.5/IAPMO Z124.
 - 2) Material: **[Molded polymer] <Insert material>.**
 - 3) Rim Guard: On **[front] [all]** top surfaces.
 - 4) Drain: Grid with **[NPS 2 (DN 50)] [NPS 3 (DN 80)]** outlet.
- d. Mounting: On floor and flush to wall.

3. Service Sinks, Floor Mounted - Molded Stone:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Fiat Products.
 - 2) Florestone Products Co., Inc.
 - 3) **<Insert manufacturer's name>.**
- b. Source Limitations: Obtain sinks from single source from single manufacturer.
- c. Fixture:
 - 1) Standard: ASME A112.18.2/CSA B125.2.
 - 2) Rim Guard: On **[front] [all]** top surfaces.
 - 3) Drain: Grid with **[NPS 2 (DN 50)] [NPS 3 (DN 80)]** outlet.

- d. Mounting: On floor and flush to wall.
- 4. Service Sinks, Floor Mounted - Enameled Cast Iron:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Commercial Enameling Company.
 - 2) Zurn Industries, LLC.
 - 3) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain sinks from single source from single manufacturer.
 - c. Fixture:
 - 1) Standard: ASME A112.19.1/CSA B45.2.
 - 2) Style: With front apron and raised back.
 - 3) Drain: Grid with **[NPS 2 (DN 50)] [NPS 3 (DN 80)]** outlet.
 - 4) Rim Guard: Coated wire.
- B. Service Sinks, Trap Standard Mounted:
 - 1. Service Sinks, Trap Standard Mounted - Enameled Cast Iron:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Commercial Enameling Company.
 - 3) Kohler Co.
 - 4) Zurn Industries, LLC.
 - 5) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain sinks from single source from single manufacturer.
 - c. Fixture:
 - 1) Standard: ASME A112.19.1/CSA B45.2.
 - 2) Type: Service sink with back.
 - 3) Mounting: **[NPS 2 (DN 50)] [NPS 3 (DN 80)]** P-trap standard with grid strainer inlet, cleanout, and floor flange.
 - 4) Rim Guard: On front and sides.
 - d. Support: **[Sink carrier] <Insert carrier>.**
- C. Kitchen/Utility Sinks:
 - 1. Kitchen/Utility Sinks, Counter Mounted - Stainless Steel:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advance Tabco.
 - 2) Amerisink Inc.
 - 3) Eagle Group.
 - 4) Elkay.
 - 5) Just Manufacturing.
 - 6) Krowne.
 - 7) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain sinks from single source from single manufacturer.
 - c. Fixture:
 - 1) Standard: ASME A112.19.3/CSA B45.4.

- 2) Type: Stainless steel, self-rimming, sound-deadened unit [**less ledge back**] [**with ledge back**].
- 3) Material: 18 gauge, Type 304 stainless steel.
- 4) Compartment:
 - a) Drain: [Grid with **NPS 1-1/2 (DN 40)** tailpiece and twist drain] [Grid with **NPS 2 (DN 50)** tailpiece and twist drain] [**NPS 1-1/2 (DN 40)** tailpiece with stopper] <Insert drain>.
 - b) Drain Location: [**Centered in compartment**] [**Near back of compartment**] [**Near left side of compartment**] [**Near right side of compartment**] <Insert location>.
- 5) Each Compartment:
 - a) Drains: [Grid with **NPS 1-1/2 (DN 40)** tailpiece and twist drain] [Grid with **NPS 2 (DN 50)** tailpiece and twist drain] [**NPS 1-1/2 (DN 40)** tailpiece with stopper] <Insert drain>.
 - b) Drain Location: [**Centered in compartment**] [**Near back of compartment**] <Insert location>.
- 6) Mounting: On ledge.
- d. Supply Fittings:
 - 1) Standard: ASME A112.18.1/CSA B125.1.
 - 2) Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - a) Operation: [**Loose key**] [**Wheel handle**] <Insert type>.
 - b) Risers: NPS 1/2 (DN 15), [**chrome-plated, rigid-copper pipe**] [**chrome-plated, soft-copper flexible tube**] [**ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose**].
- e. Waste Fittings:
 - 1) Standard: ASME A112.18.2/CSA B125.2.
 - 2) Trap(s) Size: [**NPS 1-1/2 (DN 40)**] [**NPS 2 (DN 50)**].
 - 3) Trap(s) Material:
 - a) Chrome-plated, [**two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall**] [**two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall**] <Insert trap type>; and chrome-plated brass or steel wall flange.
 - b) Stainless steel, two-piece trap and swivel elbow with 0.012-inch- (0.30-mm-) thick stainless steel tube to wall; and stainless steel wall flange.
 - 4) Continuous Waste:
 - a) Size: [**NPS 1-1/2 (DN 40)**] [**NPS 2 (DN 50)**].
 - b) Material: Chrome-plated, 17-gauge brass tube.
- f. Mounting: On counter with sealant.
2. Kitchen/Utility Sinks, Freestanding - Stainless Steel:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advance Tabco.
 - 2) AERO Manufacturing Company.
 - 3) Amtekco Industries, Inc; a Wasserstrom Company.

- 4) Eagle Group.
- 5) Elkay.
- 6) Griffin Products, Inc.
- 7) Just Manufacturing.
- 8) **<Insert manufacturer's name>.**
- b. Source Limitations: Obtain sinks from single source from single manufacturer.
- c. Fixture:
 - 1) Standards:
 - a) ASME A112.19.3/CSA B45.4.
 - b) **[NSF 2].**
 - 2) Type: Stainless steel, freestanding, sound-deadened unit with backsplash.
 - 3) Material: **[14] [16]** gauge, Type 304 stainless steel.
 - 4) Compartment:
 - a) Drain: [Grid with **NPS 1-1/2 (DN 40)** tailpiece and twist drain] [Grid with **NPS 2 (DN 50)** tailpiece and twist drain] [**NPS 1-1/2 (DN 40)** tailpiece with stopper] **<Insert drain>.**
 - b) Drain Location: **[Centered in compartment] [Near back of compartment] [Near left side of compartment] [Near right side of compartment] <Insert location>.**
 - 5) Each Compartment:
 - a) Drains: [Grid with **NPS 1-1/2 (DN 40)** tailpiece and twist drain] [Grid with **NPS 2 (DN 50)** tailpiece and twist drain] [**NPS 1-1/2 (DN 40)** tailpiece with stopper] **<Insert drain>.**
 - b) Drain Location: **[Centered in compartment] [Near back of compartment] <Insert location>.**
 - 6) Integral Drainboard(s): **[Not required] [Both] [Left] [Right]** side(s).
- d. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
- e. Faucet(s):
 - 1) Mounting: On backsplash.
- f. Supply Fittings:
 - 1) Standard: ASME A112.18.1/CSA B125.1.
 - 2) Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - a) Operation: **[Loose key] [Wheel handle] <Insert type>.**
 - b) Risers: NPS 1/2 (DN 15), **[chrome-plated, rigid-copper pipe] [chrome-plated, soft-copper flexible tube] [ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose].**
- g. Waste Fittings:
 - 1) Standard: ASME A112.18.2/CSA B125.2.
 - 2) Trap(s) Size: **[NPS 1-1/2 (DN 40)] [NPS 2 (DN 50)].**
 - 3) Trap(s) Material:
 - a) Chrome-plated, **[two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall] [two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall] <Insert trap type>;** and chrome-plated brass or steel wall flange.

- b) Stainless steel, two-piece trap and swivel elbow with 0.012-inch- (0.30-mm-) thick stainless steel tube to wall; and stainless steel wall flange.
 - 4) Continuous Waste:
 - a) Size: **[NPS 1-1/2 (DN 40)] [NPS 2 (DN 50)]**.
 - b) Material: Chrome-plated, 17-gauge brass tube.
 - D. Handwash Sinks:
 - 1. Handwash Sinks - Stainless Steel:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advance Tabco.
 - 2) AERO Manufacturing Company.
 - 3) Amtekco Industries, Inc; a Wasserstrom Company.
 - 4) Eagle Group.
 - 5) Elkay.
 - 6) Griffin Products, Inc.
 - 7) Just Manufacturing.
 - 8) Krowne.
 - 9) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain sinks from single source from single manufacturer.
 - c. Fixture:
 - 1) Standards:
 - a) ASME A112.19.3/CSA B45.4.
 - b) NSF 61.
 - 2) Type: **[Wall-mounted] [Pedestal-base]** stainless steel basin with radius corners, back for faucet, and support brackets.
 - 3) Material: **[18 gauge] [20 gauge] <Insert gauge>**, Type 304 stainless steel.
 - d. Supply Fittings: Comply with requirements in "Sink Supply Fittings" Paragraph.
 - e. Waste Fittings: Comply with requirements in "Sink Waste Fittings" Paragraph.
 - f. Support: **[Sink carrier, framing affixed] [Sink carrier, floor affixed with steel uprights] <Insert carrier>.**
- E. Sink Faucets, Manually Operated:
 - 1. Sink Faucets, Manually Operated:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Central Brass Company; a Pioneer Industries, Inc. brand.
 - 3) Chicago Faucets; Geberit Group.
 - 4) Elkay.
 - 5) Gerber Plumbing Fixtures LLC.
 - 6) Just Manufacturing.
 - 7) Kohler Co.
 - 8) Krowne.
 - 9) Speakman Company.
 - 10) T&S Brass and Bronze Works, Inc.
 - 11) Wolverine Brass, Inc.
 - 12) Zurn Industries, LLC.

- 13) **<Insert manufacturer's name>.**
- b. Source Limitations: Obtain sink faucets from single source from single manufacturer.
 - c. Standards:
 - 1) ASME A112.18.1/CSA B125.1.
 - 2) NSF 61.
 - 3) NSF 372.
 - d. Description: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 - e. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
 - f. Finish: **[Chrome plated] [Polished chrome plate] <Insert finish>.**
 - g. Mounting Type: **[Deck, concealed] [Deck, exposed] [Back/wall, exposed].**
 - h. Valve Handle(s): **[Lever] [Cross, four arm] [4-inch (102-mm) wrist blade] [6-inch (150-mm) wrist blade] [Not applicable] <Insert handles>.**
 - i. Vacuum Breaker: **[Required] [Not required]** for hose outlet.
 - j. Spout Outlet: **[Aerator] [Laminar flow] [Hose thread in accordance with ASME B1.20.7] [Plain end] [Spray] <Insert type>.**
 - k. Pre-Rinse Unit:
 - 1) Style: **[Flexible hose] [Rigid] [Combination rigid/flexible] <Insert type>.**
 - 2) Riser: **[18-inch (457-mm) rigid riser] <Insert type>.**
 - 3) Hose: **[44-inch (1117-mm) flexible stainless steel with heat-resistant handle] <Insert type>.**
 - 4) Spray valve: **<Insert type>.**
 - 5) Wall bracket.
2. Sink Faucets, Manually Operated - Service Sink:
- 1) Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:**Chicago Faucets; Geberit Group.**
 - 2) T&S Brass and Bronze Works, Inc.
 - 3) Zurn Industries, LLC.
 - 4) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain sink faucets from single source from single manufacturer.
 - c. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch (20-mm) hose thread end, integral vacuum breaker, inlets 8 inches (203 mm) o.c., and two-handle mixing.
 - d. Faucet:
 - 1) Standards:
 - a) ASME A112.18.1/CSA B125.1.
 - b) NSF 61 and NSF 372.
 - c) ICC A117.1.
 - d) ASSE 1001 (VB).
 - 2) Finish: **[Rough chrome plated] [Polished chrome plated] <Insert finish>.**
 - 3) Cartridges: **[One-fourth turn compression] [Ceramic] <Insert type>.**
 - 4) Brace: **[Adjustable top brace] [Adjustable bottom brace] <Insert type>.**
 - e. Vacuum Breaker: **[Required] [Not required]** for hose outlet.
 - f. Spout Outlet: **[Aerator] [Laminar flow] [Hose thread in accordance with ASME B1.20.7] [Plain end] [Spray] <Insert type>.**

F. Sink Faucets, Automatically Operated:

G. Sink Supply Fittings:

1. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
2. Standard: ASME A112.18.1/CSA B125.1.
3. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.
4. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
5. Operation: **[Loose key] [Wheel handle] <Insert type>**.
6. Risers:
 - a. **[NPS 3/8 (DN 10)] [NPS 1/2 (DN 15)]**.
 - b. **[Chrome-plated, rigid-copper pipe] [Chrome-plated, soft-copper flexible tube] [ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose]**.

H. Sink Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with NPS 1-1/2 (DN 40) offset and straight tailpiece.
3. Trap:
 - a. Size: NPS 1-1/2 (DN 40).
 - b. Material:
 - 1) Chrome-plated, **[two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall] [two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall] [one-piece, cast-brass trap with swivel 17-gauge tubular brass wall bend] <Insert trap type>**; and chrome-plated brass or steel wall flange.

I. Grout:

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink; recommended for interior and exterior applications.
3. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.5 COMMERCIAL URINALS

A. Urinals, Stall:

1. Urinals, Stall - Washout Type:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) **<Insert manufacturer's name>**.
 - b. Fixture:
 - 1) Standards:
 - a) ASME A112.19.2/CSA B45.1.
 - b) ASME A112.19.5/CSA B45.15.
 - 2) Material: Vitreous china.

- 3) Strainer: Separate; removable.
- 4) Outlet Size and Location: NPS 2 (DN 50); bottom for separate trap.

B. Urinals, Wall Hung:

1. Urinals, Wall Hung - Back Outlet, Blowout:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) **<Insert manufacturer's name>**.
- b. Fixture:
 - 1) Standards:
 - a) ASME A112.19.2/CSA B45.1.
 - b) ASME A112.19.5/CSA B45.15.
 - 2) Material: Vitreous china.
- c. Waste Fitting:
 - 1) Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - 2) Size: NPS 2 (DN 50).
- d. Support: **[Urinal carrier, floor affixed with steel uprights]** **<Insert carrier>** with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
- e. Urinal Mounting Height: **[Standard]** **[Juvenile]** **[Accessible in accordance with ICC A117.1]**.

2. Urinals, Wall Hung - Back Outlet, Siphon Jet:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) Zurn Industries, LLC.
 - 4) **<Insert manufacturer's name>**.
- b. Fixture:
 - 1) Standards:
 - a) ASME A112.19.2/CSA B45.1.
 - b) ASME A112.19.5/CSA B45.15.
 - 2) Material: Vitreous china.
 - 3) Type: Siphon jet[**with extended shields**].
 - 4) Strainer or Trapway: **[Manufacturer's standard strainer]** **<Insert strainer>** with integral trap.
 - 5) Water Consumption: **[0.125 gpf (0.5 Lpf)] [0.25 gpf (1.0 Lpf)] [0.5 gpf (1.9 Lpf)] [1.0 gpf (3.8 Lpf)]**.
- c. Waste Fitting:
 - 1) Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - 2) Size: NPS 2 (DN 50).

- d. Support: **[Urinal carrier, floor affixed with steel uprights]** <Insert carrier> with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
 - e. Urinal Mounting Height: **[Standard]** **[Juvenile]** **[Accessible in accordance with ICC A117.1]**.
3. Urinals, Wall Hung - Back Outlet, Washout:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advanced Modern Technologies Corporation - AMTC.
 - 2) American Standard.
 - 3) Kohler Co.
 - 4) TOTO USA, INC.
 - 5) Zurn Industries, LLC.
 - 6) **<Insert manufacturer's name>.**
 - b. Fixture:
 - 1) Standards:
 - a) ASME A112.19.2/CSA B45.1.
 - b) ASME A112.19.5/CSA B45.15.
 - 2) Material: Vitreous china.
 - 3) Type: Washout with extended shields.
 - 4) Strainer or Trapway: **[Manufacturer's standard strainer]** <Insert strainer> with integral trap.
 - 5) Spud Size and Location: NPS 3/4 (DN 20), **[back]** **[top]**.
 - 6) Outlet Size and Location: NPS 2 (DN 50), back.
 - c. Waste Fitting:
 - 1) Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - 2) Size: NPS 2 (DN 50).
 - d. Support: **[Urinal carrier, floor affixed with steel uprights]** <Insert carrier> with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
 - e. Urinal Mounting Height: **[Standard]** **[Juvenile]** **[Accessible in accordance with ICC A117.1]**.
4. Urinals, Wall Hung - Bottom Outlet, Washout:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) **<Insert manufacturer's name>.**
 - b. Fixture:
 - 1) Standards:
 - a) ASME A112.19.2/CSA B45.1.
 - b) ASME A112.19.5/CSA B45.15.
 - 2) Material: Vitreous china.
 - 3) Drain: Separate removable chrome-plated dome strainer with chrome-plated, NPS 1-1/2 (DN 40) tailpiece.

- 4) Strainer or Trapway: Manufacturer's standard strainer and NPS 1-1/2 (DN 40) tailpiece.
 - 5) Inlet Spud Size and Location: NPS 3/4 (DN 20); top.
 - 6) Outlet Size and Location: NPS 1-1/2 (DN 40); bottom.
 - c. Waste Fitting:
 - 1) Standard: ASME A112.18.2/CSA B125.2.
 - 2) Trap:
 - a) Size: NPS 1-1/2 (DN 50).
 - b) Material, Chrome Plated: **[Two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall] [two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall] [one-piece, cast-brass trap with swivel 0.029-inch- (73-mm-) thick tubular brass wall bend] <Insert trap type>;** and chrome-plated brass or steel wall flange.
 - c) Material, Stainless Steel: Two-piece trap and swivel elbow with 0.012-inch- (0.30-mm-) thick, stainless steel tube to wall; and stainless steel wall flange.
 - d. Support: **[Urinal carrier, floor affixed with steel uprights] <Insert carrier>** with hanger and bearing plates.
 - e. Urinal Mounting Height: **[Standard] [Juvenile] [Accessible in accordance with ICC A117.1].**
5. Urinals, Wall Hung - Back Outlet, Washdown:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advanced Modern Technologies Corporation - AMTC.
 - 2) American Standard.
 - 3) Kohler Co.
 - 4) TOTO USA, INC.
 - 5) Zurn Industries, LLC.
 - 6) **<Insert manufacturer's name>.**
 - b. Fixture:
 - 1) Standards:
 - a) ASME A112.19.2/CSA B45.1.
 - b) ASME A112.19.5/CSA B45.15.
 - 2) Material: Vitreous china.
 - 3) Type: Washdown with extended shields.
 - 4) Strainer or Trapway: **[Manufacturer's standard strainer] <Insert strainer>** with integral trap.
 - 5) Water Consumption: **[0.125 gpf (0.5 Lpf)] [0.25 gpf (1.0 Lpf)] [0.5 gpf (1.9 Lpf)] [1.0 gpf (3.8 Lpf)].**
 - 6) Spud Size and Location: NPS 3/4 (DN 20), **[back] [top].**
 - 7) Outlet Size and Location: NPS 2 (DN 50), back.
 - c. Flushometer Valve: **<Insert urinal flushometer-valve designation from "Flushometer Valves" Article>.**
 - d. Waste Fitting:
 - 1) Standard: ASME A112.18.2/CSA B125.2 for coupling.

2) Size: NPS 2 (DN 50).

- e. Support: **[Urinal carrier, floor affixed with steel uprights]** <Insert carrier> with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.
- f. Urinal Mounting Height: **[Standard]** **[Juvenile]** **[Accessible in accordance with ICC A117.1]**.

2.6 COMMERCIAL WATER CLOSETS

A. Water Closets, Floor Mounted:

1. Water Closets, Floor Mounted - Bottom Outlet, Top Spud <Insert drawing designation>:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advanced Modern Technologies Corporation - AMTC.
 - 2) American Standard.
 - 3) Kohler Co.
 - 4) Sloan Valve Company.
 - 5) TOTO USA, INC.
 - 6) Zurn Industries, LLC.
 - 7) **<Insert manufacturer's name>.**
- b. Source Limitations: Obtain water closets from single source from single manufacturer.
- c. Standard: ASME A112.19.2/CSA B45.1.
- d. Bowl:
 - 1) Material: Vitreous china.
 - 2) Type: Siphon jet.
 - 3) Style: Flushometer valve.
 - 4) Height: **[Standard]** **[Accessible in accordance with ICC A117.1]**.
 - 5) Rim Contour: Elongated.
 - 6) Water Consumption: **[1.1 gal. (4.2 L)] [1.28 gal. (4.8 L)] [1.6 gal. (6 L)] [Dual flush 1.1 gal. (4.2 L)/1.28 gal. (4.8 L)] [Dual flush 1.1 gal. (4.2 L)/1.6 gal. (6 L)]** per flush.
 - 7) Spud Size and Location: **NPS 1-1/2 (DN 40)**; top.
- e. Flushometer Valve: <Insert flushometer-valve designation>.
- f. Toilet Seat: **<Insert toilet-seat designation>.**

B. Water Closets, Wall Mounted:

1. Water Closets, Wall Mounted - Top Spud:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advanced Modern Technologies Corporation - AMTC.
 - 2) American Standard.
 - 3) Kohler Co.
 - 4) Sloan Valve Company.
 - 5) TOTO USA, INC.
 - 6) Zurn Industries, LLC.
 - 7) **<Insert manufacturer's name>.**
- b. Source Limitations: Obtain water closets from single source from single manufacturer.

- c. Standard: ASME A112.19.2/CSA B45.1.
 - d. Bowl:
 - 1) Material: Vitreous china.
 - 2) Type: Siphon jet.
 - 3) Style: Flushometer valve.
 - 4) Mounting Height: **[Standard] [Juvenile] [Accessible in accordance with ICC A117.1].**
 - 5) Rim Contour: Elongated.
 - e. Flushometer Valve: **<Insert flushometer-valve designation>.**
 - f. Toilet Seat: **<Insert toilet-seat designation>.**
 - g. Support: **[Water-closet carrier, floor affixed] <Insert carrier>.**
2. Water Closets, Wall Mounted - Back Spud:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) Sloan Valve Company.
 - 4) TOTO USA, INC.
 - 5) Zurn Industries, LLC.
 - 6) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain water closets from single source from single manufacturer.
 - c. Standard: ASME A112.19.2/CSA B45.1.
 - d. Bowl:
 - 1) Material: Vitreous china.
 - 2) Type: Siphon jet.
 - 3) Style: Flushometer valve.
 - 4) Mounting Height: **[Standard] [Juvenile] [Accessible in accordance with ICC A117.1].**
 - 5) Rim Contour: Elongated.
 - e. Flushometer Valve: **<Insert flushometer-valve designation>.**
 - f. Toilet Seat: **<Insert toilet-seat designation>.**
 - g. Support: **[Water-closet carrier, floor affixed] <Insert carrier>.**
3. Water Closets, Wall Mounted - Back Outlet, Close-Coupled Flushometer Tank:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain water closets from single source from single manufacturer.
 - c. Standard: ASME A112.19.2/CSA B45.1.
 - d. Bowl:
 - 1) Material: Vitreous china.
 - 2) Type: Siphon jet.
 - 3) Style: Flushometer tank, **[gravity] [pressure assisted].**
 - 4) Height: **[Standard] [Accessible in accordance with ICC A117.1].**
 - 5) Rim Contour: Elongated.

- e. Toilet Seat: **<Insert toilet-seat designation>**.
- f. Support: [**Water-closet carrier, floor affixed**] **<Insert carrier>**.

2.7 FLUSHOMETER VALVES

A. Flushometer Valves, Manually Operated:

1. Flushometer Valves, Manually Operated - Diaphragm, Lever Handle:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advanced Modern Technologies Corporation - AMTC.
 - 2) American Standard.
 - 3) Sloan Valve Company.
 - 4) Zurn Industries, LLC.
 - 5) **<Insert manufacturer's name>**.
- b. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
- c. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
- d. Minimum Pressure Rating: 125 psig (860 kPa).
- e. Features: Include integral check stop and backflow-prevention device.
- f. Material: Brass body with corrosion-resistant components.
- g. Style: Exposed.
- h. Flushometer-Valve Finish: Chrome-plated.
- i. Handle Finish: [**Chrome plated**] [**Antimicrobial**].

2. Flushometer Valves, Manually Operated - Piston, Lever Handle:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) Sloan Valve Company.
 - 4) TOTO USA, INC.
 - 5) Zurn Industries, LLC.
 - 6) **<Insert manufacturer's name>**.
- b. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
- c. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
- d. Minimum Pressure Rating: 125 psig (860 kPa).
- e. Features: Include integral check stop and backflow-prevention device.
- f. Material: Brass body with corrosion-resistant components.
- g. Style: Exposed.
- h. Flushometer-Valve Finish: Chrome-plated.
- i. Handle Finish: [**Chrome-plated**] [**Antimicrobial**].

B. Flushometer Valves, Sensor Operated:

1. Flushometer Valves, Sensor Operated - Diaphragm:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) Advanced Modern Technologies Corporation - AMTC.
 - 2) Sloan Valve Company.

- 3) Zurn Industries, LLC.
 - 4) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
 - c. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
 - d. Minimum Pressure Rating: 125 psig (860 kPa).
 - e. Features: Include integral check stop and backflow-prevention device.
 - f. Material: Brass body with corrosion-resistant components.
 - g. Style: **[Exposed] [Concealed]**.
 - h. Exposed Flushometer-Valve Finish: Chrome-plated.
 - i. Panel Finish: Chrome-plated or stainless steel.
 - j. Actuator: Side or top mounted; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
 - k. Trip Mechanism: **[Battery-powered] [Hardwired, control-voltage]** electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
2. Flushometer Valves, Sensor Operated - Piston, Hardwired:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Moen Incorporated.
 - 3) Sloan Valve Company.
 - 4) Zurn Industries, LLC.
 - 5) **<Insert manufacturer's name>.**
 - b. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
 - c. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
 - d. Minimum Pressure Rating: 125 psig (860 kPa).
 - e. Features: Include integral check stop and backflow-prevention device.
 - f. Material: Brass body with corrosion-resistant components.
 - g. Style: **[Exposed] [Concealed]**.
 - h. Exposed Flushometer-Valve Finish: Chrome-plated.
 - i. Panel Finish: Chrome-plated or stainless steel.
 - j. Trip Mechanism: Hardwired, control-voltage electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
3. Flushometer Valves, Sensor Operated - Piston, Battery Powered:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - 1) American Standard.
 - 2) Kohler Co.
 - 3) Moen Incorporated.
 - 4) Sloan Valve Company.
 - 5) TOTO USA, INC.
 - 6) Zurn Industries, LLC.
 - 7) **<Insert manufacturer's name>.**
 4. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
 5. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
 6. Minimum Pressure Rating: 125 psig (860 kPa).
 7. Features: Include integral check stop and backflow-prevention device.

8. Material: Brass body with corrosion-resistant components.
9. Style: **[Exposed]** **[Concealed]**.
10. Exposed Flushometer-Valve Finish: Chrome plated.
11. Panel Finish: Chrome-plated or stainless steel.
12. Trip Mechanism: Battery-powered electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.

2.8 TOILET SEATS

A. Toilet Seats:

1. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - a. American Standard.
 - b. Bemis Manufacturing Company.
 - c. Centoco Manufacturing Corporation.
 - d. Church Seats; Bemis Manufacturing Company.
 - e. Jones Stephens Corp.
 - f. Kohler Co.
 - g. ProFlo; a Ferguson Enterprises, Inc. brand.
 - h. TOTO USA, INC.
 - i. Zurn Industries, LLC.
 - j. **<Insert manufacturer's name>.**
2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Standard: IAPMO/ANSI Z124.5.
4. Material: Plastic.
5. Type: Commercial (Heavy duty).
6. Shape: **[Elongated rim, open front]** **[Elongated rim, closed front]** **<Insert shape>.**
7. Hinge: **[Check]** **[Self-sustaining, check].**
8. Hinge Material: Noncorroding metal.
9. Seat Cover: **[Required]** **[Not required].**
10. Color: **[White]** **<Insert color>.**
11. Surface Treatment: **[Antimicrobial]** **[Not required].**

2.9 FIXTURE CARRIERS

A. Fixture Carriers - Lavatory:

1. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade; a subsidiary of McWane Inc.
 - e. WATTS; A Watts Water Technologies Company.
 - f. Zurn Industries, LLC.
 - g. **<Insert manufacturer's name>.**
2. Source Limitations: Obtain lavatory carriers from single source from single manufacturer.
3. Standards:
 - a. ASME A112.6.1M.
 - b. ASME A112.6.2.

B. Fixture Carriers - Sink:

1. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:

- a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade; a subsidiary of McWane Inc.
 - e. WATTS; A Watts Water Technologies Company.
 - f. Zurn Industries, LLC.
 - g. **<Insert manufacturer's name>.**
 2. Source Limitations: Obtain sink carriers from single source from single manufacturer.
 3. Standards:
 - a. ASME A112.6.1M.
 - b. ASME A112.6.2.
- C. Fixture Carriers - Urinal:
1. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade; a subsidiary of McWane Inc.
 - e. WATTS; A Watts Water Technologies Company.
 - f. Zurn Industries, LLC.
 - g. **<Insert manufacturer's name>.**
 2. Source Limitations: Obtain urinal carriers from single source from single manufacturer.
 3. Standard: ASME A112.6.1M.
 4. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings, gaskets, and feet; bolts and hardware matching fixture. **[Include additional extension coupling, faceplate, and feet for installation in wide pipe space.]**
- D. Fixture Carriers - Water Closet:
1. Basis-of-Design Product: Subject to compliance with requirements, provide products as indicated on Drawings or a comparable product by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade; a subsidiary of McWane Inc.
 - e. WATTS; A Watts Water Technologies Company.
 - f. Zurn Industries, LLC.
 - g. **<Insert manufacturer's name>.**
 2. Source Limitations: Obtain water closet carriers from single source from single manufacturer.
 3. Standard: ASME A112.6.1M.
 4. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings, gaskets, and feet; bolts and hardware matching fixture. **[Include additional extension coupling, faceplate, and feet for installation in wide pipe space.]**
 5. Load Capacity: **[500] [750] [1000]** pounds.

PART 3 - EXECUTION – NOT USED

END OF SECTION 224200

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SECTION 226600 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 70.

2.2 PERFORMANCE REQUIREMENTS

- A. Single-Wall Piping Pressure Rating: **[5-psig 34.5-kPa] <Insert value> [air test pressure] [10 feet head 3.05 m of water for 30 minutes] <Insert value and time>.**
- B. Double-Containment Piping Pressure Rating:
 - 1. Carrier Piping: **[5-psig 34.5-kPa] <Insert value> [air test pressure] [10 feet head 3.05 m of water for 30 minutes] <Insert value and time>.**
 - 2. Containment Piping: **[5-psig 34.5-kPa] <Insert value> [air test pressure] <Insert test method>.**
- C. Field-Fabrication Containment-Piping Pressure Rating: **[5-psig 34.5-kPa] <Insert value> [air test pressure] <Insert test method>.**
- D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for aboveground piping.

2.3 SINGLE-WALL PIPE AND FITTINGS

- A. PP Drainage Pipe and Fittings: ASTM F1412, extruded pipe and drainage-pattern fittings molded, with Schedule 40 dimensions and with fire-retardant additive complying with ASTM D4101; with **[fusion-] [and] [mechanical-]joint ends.**
 - 1. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GF Piping Systems: Georg Fischer LLC.
 - b. IPEX USA LLC.
 - c. Orion Fittings: A Watts Water Technologies Company.
 - d. Town & Country Plastics, Inc.
 - e. Zurn Industries, LLC.
 - f. **<Insert manufacturer's name>.**
 - 3. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.
- B. CPVC Drainage Pipe and Fittings: ASTM F2618, pipe and drainage-pattern fittings.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Spears Manufacturing Company.
 - c. **<Insert manufacturer's name>.**

2. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.
 - C. PVDF Drainage Pipe and Fittings: ASTM F1673, Schedule 40, pipe and drainage-pattern fittings. Include fittings with **[fusion-]** **[and]** **[mechanical-]** joint ends.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GF Piping Systems: Georg Fischer LLC.
 - b. IPEX USA LLC.
 - c. Orion Fittings: A Watts Water Technologies Company.
 - d. Zurn Industries, LLC.
 - e. **<Insert manufacturer's name>.**
 2. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.
 - D. Stainless Steel Drainage Pipe and Fittings: ASME A112.3.1, ASTM A666, Type 316L, stainless steel pipe and drainage-pattern fittings; with socket-and-spigot ends for gasket joints; and having piping manufacturer's FPM lip-seal rubber gaskets shaped to fit socket groove, with plastic backup ring.
 1. Manufacturers: Subject to compliance with requirements, provide products by **[one of]** the following:
 - a. Josam Company.
 - b. **<Insert manufacturer's name>.**
 2. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.
- 2.4 DOUBLE-CONTAINMENT PIPE AND FITTINGS
- A. Description: Factory-fabricated, double-wall pipe and fittings. Sizes indicate carrier-pipe size; with carrier (inner) pipe and fittings; annular-space, carrier-pipe supports; containment (outer) pipe and fittings; and joining materials and fasteners.
 - B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Asahi/America.
 2. Flo Safe, Inc.
 3. GF Piping Systems: Georg Fischer LLC.
 4. Insul-Tek Piping Systems, Inc.
 5. IPEX USA LLC.
 6. Orion Fittings: A Watts Water Technologies Company.
 7. Performance Pipe.
 8. **<Insert manufacturer's name>.**
 - C. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.
 - D. Piping Materials:
 1. PP Double-Containment Drainage Pipe and Fittings: Made of ASTM D4101 PP resin.
 - a. Carrier and Containment Pipes: ASTM F1412, Schedule 40.
 - b. Fittings: ASTM F1412, Schedule 40 drainage pattern complying with ASTM D3311.
 2. PVDF Double-Containment Drainage Pipe and Fittings: Made of ASTM D3222 PVDF resin.
 - a. Carrier and Containment Pipes: ASTM F1673, Schedule 40.
 - b. Fittings: ASTM F1673, Schedule 40 drainage pattern complying with ASTM D3311.

- E. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

2.5 FIELD-FABRICATION CONTAINMENT PIPING

- A. Description: Containment split pipe and split fittings with carrier-pipe centralizers. Include manufacturer's fastening devices and materials.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flo Safe, Inc.
 - 2. GF Piping Systems: Georg Fischer LLC.
 - 3. **<Insert manufacturer's name>**.
- C. Source Limitations: Obtain containment piping from single source from single manufacturer.
- D. Material: **[HDPE] [PP]** pipe and fittings.
- E. Fastening System: FPM gaskets, clamps, and pins.

2.6 JOINING MATERIALS

- A. Couplings: Assemblies with combinations of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.
- B. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.
- C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.
- D. Solvent Cement for Joining CPVC Piping: ASTM F493. Include primer in accordance with ASTM F656.
 - 1. Solvent cement shall have a VOC content of 510 g/L or less.
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 3. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 4. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 - 5. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.7 PIPING SPECIALTIES

- A. Plastic Dilution Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GF Piping Systems: Georg Fischer LLC.
 - b. IPEX USA LLC.
 - c. Orion Fittings; A Watts Water Technologies Company.
 - d. Town & Country Plastics, Inc.
 - e. Zurn Industries, LLC.
 - f. **<Insert manufacturer's name>.**
 2. Source Limitations: Obtain traps from single source from single manufacturer.
 3. Material: Corrosion-resistant PP, with removable base.
 4. End Connections: Mechanical joint.
 5. Dilution Tanks: 1-gal. (3.8-L) capacity, with clear base unless colored base is indicated; with two NPS 1-1/2 (DN 40) top inlets and one NPS 1-1/2 (DN 40) side outlet.
 6. Small Dilution Jars: 1-pint (0.5-L) capacity, with clear base unless colored base is indicated; with NPS 1-1/2 (DN 40) top inlet and NPS 1-1/2 (DN 40) side outlet.
 7. Large Dilution Jars: 1-quart (1-L) capacity; with NPS 1-1/2 (DN 40) top inlet and NPS 1-1/2 (DN 40) side outlet.
- B. Corrosion-Resistant Traps:
1. Type: P-trap or drum trap.
 2. Size: NPS 1-1/2 or NPS 2 (DN 40 or DN 50), as required to match connected piping.
 3. High-Silicon Iron: ASTM A861, with horizontal outlet and hub-and-plain or plain ends to match connecting piping.
 4. PP: ASTM D4101, with mechanical-joint pipe connections.
 5. PVDF: ASTM D3222, with mechanical-joint pipe connections.
 6. Glass: ASTM C1053, with coupling pipe connections.
- C. Stainless Steel Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. **<Insert manufacturer's name>.**
 2. Source Limitations: Obtain floor drains from single source from single manufacturer.
 3. Standard: ASME A112.3.1; ASTM A666, Type 316L.
 4. Body: With **[8.5-by-8.5-inch (215-by-215-mm)] [12.4-by-12.4-inch (315-by-315-mm)]** top with grate.
 5. Outlet: Bottom, of size indicated.
- D. Stainless Steel Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. **<Insert manufacturer's name>.**
 2. Source Limitations: Obtain cleanouts from single source from single manufacturer.
 3. Standard: ASME A112.3.1; ASTM A666, Type 316L.
 4. Aboveground Piping: Cleanout tee of size matching piping.
 5. Underground and Underslab Piping: Floor access cleanout of size matching piping.

E. Plastic Backwater Valves:

1. Description: Full-port NPS 3 (DN 80) check valve, PP or PVDF, matching or compatible with system piping and compatible with system liquid, with EPDM seals and flanged ends.
 - a. Exception: PVC material for use with PVC piping systems.

F. PP Sink Outlets:

1. Description: NPS 1-1/2 (DN 40), with clamping device, stopper, and 7-inch- (178-mm-) high overflow fitting.

2.8 NEUTRALIZATION TANKS

A. Plastic Neutralization Tanks:

1. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chem-Tainer Industries.
 - b. GF Piping Systems: Georg Fischer LLC.
 - c. IPEX USA LLC.
 - d. Orion Fittings; A Watts Water Technologies Company.
 - e. Schier Products Company.
 - f. Town & Country Plastics, Inc.
 - g. WATTS; A Watts Water Technologies Company.
 - h. Zurn Industries, LLC.
 - i. **<Insert manufacturer's name>.**
3. Source Limitations: Obtain tanks from single source from single manufacturer.
4. Material: **[HDPE] [HDPE or ASTM D4101 PP] [ASTM D4101 PP].**
5. Tank Capacity: **<Insert capacity>.**
6. Dip Tube: On outlet pipe instead of inlet pipe.
7. Extension: HDPE, PE, or PP.
8. Traffic Cover: **[Light-duty] [Heavy-duty pedestrian or light-duty vehicular, steel plate over]** plastic, bolted.
9. Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
10. Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.

2.9 MANHOLES - HOLDING TANKS

- A. Description: ASTM F1759, fabricated from PE components. Include bottom, sidewalls, and top sections; corrosion-resistant, tanks frame and cover; fusion or other watertight joints; and design to prohibit flotation.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ayer Sales, Inc.
 2. ISCO Industries, LLC.
 3. Performance Pipe.
 4. Plastic Fusion Fabricators, Inc.
 5. PolyPipe Brand; Dura-Line.
 6. Zurn Industries, LLC.

7. <Insert manufacturer's name>.

- C. Source Limitations: Obtain holding tanks from single source from single manufacturer.
- D. Construction: [**Single wall**] [**Double wall with interstitial space**].
- E. Bottom: Channeled.
- F. Connections: Inlets and outlet matching or suitable for piping.
- G. Steps: Manufacturer's standard, fusion welded to sidewall. Omit steps for manholes less than [**60 inches (1500 mm)**] <Insert dimension> deep.
- H. Top: Include 24-inch (610-mm) nominal-diameter frame and cover.

2.10 LEAK-DETECTION SYSTEMS

A. Leak-Detection Systems:

- 1. Description: Cable leak-detection system capable of detecting and annunciating fluid leaks; with controls, panel, wiring, cable sensors, probes if required, and piping.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. Flo Safe, Inc.
 - c. IPEX USA LLC.
 - d. Pentair Thermal Management.
 - e. PermAlert.
 - f. <Insert manufacturer's name>.
- 3. Source Limitations: Obtain leak-detection systems from single source from single manufacturer.
- 4. Annunciator Panel: Enclosure with visual and audible alarms and leak-location indicator.
- 5. Sensors: Electric cable, suitable for insertion in double-containment piping annular space, with capability of detecting fluid leaks and signaling locations of leaks.

PART 3 - EXECUTION – NOT USED

END OF SECTION 226600

SECTION 226713 - PROCESSED WATER PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure Ratings:

1. Reagent-Water Piping: **[20 psig 138 kPa] [40 psig 276 kPa] [50 psig 345 kPa] [100 psig 690 kPa] <Insert pressure>** unless otherwise indicated.
2. Deionized-Water Piping: **[50 psig 345 kPa] [100 psig 690 kPa] [150 psig 1035 kPa] <Insert pressure>** unless otherwise indicated.
3. Distilled-Water Piping: **[50 psig 345 kPa] [100 psig 690 kPa] [150 psig 1035 kPa] <Insert pressure>** unless otherwise indicated.
4. RO Water Piping: **[50 psig 345 kPa] [100 psig] [150 psig 1035 kPa] <Insert pressure>** unless otherwise indicated.

B. Seismic Performance: Water piping shall withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7] <Insert requirement>**.

1. The term "withstand" means "the piping system will remain in place without separation of any parts when subjected to the seismic forces specified **[and the piping system will be fully operational after the seismic event].**"
2. Component Importance Factor: **[1.5] [1.0]**.
3. **<Insert requirements for Component Amplification Factor and Component Response Modification Factor>**.

2.2 PLASTIC PIPE AND FITTINGS

A. Standards: Comply with NSF 14, NSF 61, and NSF 372.

B. CPVC Pipe and Fittings, Schedule 40: ASTM F441/F441M pipe; with plain ends for solvent-cemented joints and ASTM F438 socket-type fittings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. GF Piping Systems.
 - c. **<Insert manufacturer's name>**.

C. CPVC Pipe and Fittings, Schedule 80: ASTM F441/F441M pipe; with plain ends for solvent-cemented joints and ASTM F439 socket-type fittings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. GF Piping Systems.
 - c. **<Insert manufacturer's name>**.

D. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

1. Solvent cement shall have a VOC content of 490 g/L or less.

2. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 3. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 4. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 5. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- E. PP Pipe and Fittings for Heat-Fusion Joints: Made from ASTM D4101 PP resin.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. GF Piping Systems: Georg Fischer LLC.
 - c. IPEX USA LLC.
 - d. NIBCO INC.
 - e. Orion Fittings; A Watts Water Technologies Company.
 - f. Town & Country Plastics, Inc.
 - g. **<Insert manufacturer's name>.**
- F. PP Pipe and Fittings, Schedule 40: Schedule 40 or SDR 11 dimensions; with socket- or butt-fusion fittings matching pipe dimensions.
- G. PP Pipe and Fittings for Electro-Fusion Joints: Made from ASTM D4101 PP resin.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GF Piping Systems: Georg Fischer LLC.
 - b. IPEX USA LLC.
 - c. NIBCO INC.
 - d. Orion Fittings; A Watts Water Technologies Company.
 - e. Town & Country Plastics, Inc.
 - f. **<Insert manufacturer's name>.**
 2. PP Pipe and Fittings, Schedule 80: Schedule 80 or SDR dimensions; with socket fittings matching pipe dimensions.
 3. Electro-Fusion Fitting: Electrical-resistance heating coil for PP piping joints.
- H. PVC Pipe and Fittings, Schedule 40: ASTM D1785 pipe; with plain ends for solvent-cemented joints and ASTM D2466 socket-type fittings.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.

- b. GF Piping Systems.
 - c. **<Insert manufacturer's name>.**
 - I. PVC Pipe and Fittings, Schedule 80: ASTM D1785 pipe; with plain ends for solvent-cemented joints and ASTM D2467 socket-type fittings.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. GF Piping Systems.
 - c. **<Insert manufacturer's name>.**
 - J. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.
 - 1. Solvent cement shall have a VOC content of 510 g/L or less.
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 3. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 4. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 - 5. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
 - K. PVDF Pipe and Fittings: Made from ASTM D3222 PVDF resin.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. GF Piping Systems: Georg Fischer LLC.
 - c. NIBCO INC.
 - d. Orion Fittings; A Watts Water Technologies Company.
 - e. **<Insert manufacturer's name>.**
 - 2. PVDF Pipe and Fittings, Schedule 40: Schedule 40 or SDR 11 dimensions; with socket- or butt-fusion fittings matching pipe dimensions.
 - 3. PVDF Pipe and Fittings, Schedule 80: Pipe made in accordance with ASTM D3222, Schedule 80 or SDR; with socket-fusion fittings matching pipe dimensions.
- 2.3 STAINLESS STEEL TUBING
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. LinkPlus USA.

2. Shaw Stainless & Alloy Piping.
 3. WEBCO Industries.
 4. **<Insert manufacturer's name>.**
- B. Stainless Steel Tube: ASTM A270/A270M, Grade TP304L or TP316L, seamless, sanitary tube of pharmaceutical quality, with wall thickness [**not less than ASTM A312/A312M, Schedule 5**] **<Insert wall-thickness data>** unless otherwise indicated; with seamless, stainless steel fittings matching tube thickness and grade, for welded joints.
- C. Stainless Steel Tube Fittings: Fabricated of same material and thickness as tubing for butt welding.
- D. Finish on Inside Surface of Tubes and Fittings: [**Ra 20-micro-inch (Ra 0.5-micro-m) maximum**] **<Insert finish>** roughness.
- E. Finish on Outside Surface of Tubes and Fittings: **<Insert finish>.**
- 2.4 TRANSITION FITTINGS
- A. Couplings, flanges, or other manufactured fittings; same size as, with pressure rating at least equal to, and ends compatible with piping to be joined.
- 2.5 CPVC VALVES
- A. CPVC Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. GF Piping Systems: Georg Fischer LLC.
 - e. Hayward Flow Control; Hayward Industries, Inc.
 - f. IPEX USA LLC.
 - g. NIBCO INC.
 - h. Plast-O-Matic Valves, Inc.
 - i. Spears Manufacturing Company.
 - j. Thermoplastic Valves, Inc.
 - k. **<Insert manufacturer's name>.**
 2. Description:
 - a. Standards: Comply with MSS SP-122 and ASTM F1970.
 - b. Pressure Rating: [**150 psig (1035 kPa)**] **<Insert pressure>** at [**73 deg F (23 deg C)**] **<Insert temperature>.**
 - c. Body Material: ASTM D1784 CPVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D1784 CPVC compound.
 - g. Port: Full.
 - h. Seats: PTFE.
 - i. Stem: ASTM D1784 CPVC compound.
 - j. Stem Seals: [**EPDM**] [**FKM**]-rubber O-rings.
 - k. Handle: Tee shaped.

B. CPVC Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Colonial Engineering, Inc.
 - b. GF Piping Systems: Georg Fischer LLC.
 - c. Hayward Flow Control; Hayward Industries, Inc.
 - d. IPEX USA LLC.
 - e. NIBCO INC.
 - f. Spears Manufacturing Company.
 - g. Thermoplastic Valves, Inc.
 - h. **<Insert manufacturer's name>.**
2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - c. Body Material: ASTM D1784 CPVC compound.
 - d. Body Design: **[Lug] [or] [wafer]** type.
 - e. Seat: **[EPDM] [FKM]** rubber.
 - f. Disc: **[ASTM D1784 CPVC compound] [ASTM D4101 PP resin] <Insert material>.**
 - g. Stem: Stainless steel.
 - h. Stem Seals: **[EPDM] [FKM]**-rubber O-rings.
 - i. Handle: Lever type with locking device.

C. CPVC Ball-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. GF Piping Systems: Georg Fischer LLC.
 - e. Hayward Flow Control; Hayward Industries, Inc.
 - f. IPEX USA LLC.
 - g. NIBCO INC.
 - h. Thermoplastic Valves, Inc.
 - i. **<Insert manufacturer's name>.**
2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - c. Body Material: ASTM D1784 CPVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D1784 CPVC compound.
 - g. Seat and Seals: **[EPDM] [or] [FKM]**-rubber O-rings.

D. CPVC Swing-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.

- b. Spears Manufacturing Company.
 - c. Thermoplastic Valves, Inc.
 - d. **<Insert manufacturer's name>.**
 - 2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - c. Body Material: ASTM D1784 CPVC compound.
 - d. Body Design: Bolted-bonnet type.
 - e. End Connections: Flanged.
 - f. Shaft: ASTM D1784 CPVC compound.
 - g. Disc and Arm: ASTM D1784 CPVC compounds.
 - h. Gasket and Seals: **[EPDM] [or] [FKM]** rubber.
- E. CPVC Diaphragm Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. Colonial Engineering, Inc.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. Hayward Flow Control; Hayward Industries, Inc.
 - e. NIBCO INC.
 - f. Spears Manufacturing Company.
 - g. Thermoplastic Valves, Inc.
 - h. **<Insert manufacturer's name>.**
 - 2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - c. Body Material: ASTM D1784 CPVC compound.
 - d. Body Design: Bolted-bonnet type.
 - e. End Connections for NPS 2 (DN 50) and Smaller: Detachable, socket.
 - f. End Connections for NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Flanged.
 - g. Diaphragm: **[EPDM] [FKM]** rubber.
 - h. Seals: **[EPDM] [FKM]**-rubber O-rings.
 - i. Handle: Wheel type.
- 2.6 PP VALVES
- A. PP Ball Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. GF Piping Systems: Georg Fischer LLC.
 - c. IPEX USA LLC.
 - d. NIBCO INC.
 - e. Orion Fittings: A Watts Water Technologies Company.
 - f. Plast-O-Matic Valves, Inc.
 - g. Thermoplastic Valves, Inc.
 - h. **<Insert manufacturer's name>.**

2. Description:
 - a. Standard: MSS SP-122.
 - b. Pressure Rating: **[150 psig (1035 kPa)]** <Insert pressure> at **[73 deg F (23 deg C)]** <Insert temperature>.
 - c. Body Material: ASTM D4101 PP resin.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, butt or socket.
 - f. Ball: ASTM D4101 PP resin.
 - g. Port: Full.
 - h. Seats: PTFE.
 - i. Stem: ASTM D4101 PP resin.
 - j. Stem Seals: FKM-rubber O-rings.
 - k. Handle: Tee shaped.

B. PP Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. GF Piping Systems: Georg Fischer LLC.
 - e. Hayward Flow Control; Hayward Industries, Inc.
 - f. IPEX USA LLC.
 - g. Spears Manufacturing Company.
 - h. Thermoplastic Valves, Inc.
 - i. <Insert manufacturer's name>.
2. Description:
 - a. Pressure Rating: **[150 psig (1035 kPa)]** <Insert pressure> at **[73 deg F (23 deg C)]** <Insert temperature>.
 - b. Body Material: ASTM D4101 PP resin.
 - c. Body Design: **[Lug]** [or] **[wafer]** type.
 - d. Seat: FKM rubber.
 - e. Disc: **[ASTM D4101 PP resin]** <Insert material>.
 - f. Stem: Stainless steel.
 - g. Stem Seals: FKM-rubber O-rings.
 - h. Handle: Lever type with locking device.

C. PP Ball-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. Hayward Flow Control; Hayward Industries, Inc.
 - e. NIBCO INC.
 - f. Thermoplastic Valves, Inc.
 - g. <Insert manufacturer's name>.
2. Description:
 - a. Pressure Rating: **[150 psig (1035 kPa)]** <Insert pressure> at **[73 deg F (23 deg C)]** <Insert temperature>.

- b. Body Material: ASTM D4101 PP resin.
- c. Body Design: Union type.
- d. End Connections: Detachable, socket.
- e. Ball: ASTM D4101 PP resin.
- f. Seat and Seals: FKM-rubber O-rings.

D. PP Swing-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Hayward Flow Control; Hayward Industries, Inc.
 - d. Spears Manufacturing Company.
 - e. Thermoplastic Valves, Inc.
 - f. **<Insert manufacturer's name>.**
2. Description:
 - a. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - b. Body Material: ASTM D4101 PP resin.
 - c. Body Design: Bolted-bonnet type.
 - d. End Connections: Flanged.
 - e. Shaft: ASTM D4101 PP resin.
 - f. Disc and Arm: ASTM D4101 PP resin.
 - g. Gasket and Seals: FKM rubber.

E. PP Diaphragm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. NIBCO INC.
 - e. Spears Manufacturing Company.
 - f. Thermoplastic Valves, Inc.
 - g. **<Insert manufacturer's name>.**
2. Description:
 - a. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - b. Body Material: ASTM D4101 PP resin.
 - c. Body Design: Bolted-bonnet type.
 - d. End Connections for NPS 2 (DN 50) and Smaller: Detachable, socket.
 - e. End Connections for NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Flanged.
 - f. Diaphragm: FKM rubber.
 - g. Seals: FKM-rubber O-rings.
 - h. Handle: Wheel type.

2.7 PVC VALVES

A. PVC Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. GF Piping Systems: Georg Fischer LLC.
 - e. Hayward Flow Control; Hayward Industries, Inc.
 - f. IPEX USA LLC.
 - g. NIBCO INC.
 - h. Plast-O-Matic Valves, Inc.
 - i. Spears Manufacturing Company.
 - j. Thermoplastic Valves, Inc.
 - k. **<Insert manufacturer's name>.**
2. Description:
 - a. Standards: Comply with MSS SP-122 and ASTM F1970.
 - b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - c. Body Material: ASTM D1784 PVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D1784 PVC compound.
 - g. Port: Full.
 - h. Seats: PTFE.
 - i. Stem: ASTM D1784 PVC compound.
 - j. Seals: **[EPDM] [FKM]-rubber O-rings.**
 - k. Handle: Tee shaped.

B. PVC Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. GF Piping Systems: Georg Fischer LLC.
 - e. Hayward Flow Control; Hayward Industries, Inc.
 - f. NIBCO INC.
 - g. Spears Manufacturing Company.
 - h. Thermoplastic Valves, Inc.
 - i. **<Insert manufacturer's name>.**
2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - c. Body Material: ASTM D1784 PVC compound.
 - d. Body Design: **[Lug] [or] [wafer]** type.
 - e. Seat: **[EPDM] [FKM]** rubber.
 - f. Disc: **[ASTM D1784 PVC compound] [ASTM D4101 PP resin] <Insert material>.**
 - g. Stem: Stainless steel.

- h. Stem Seals: **[EPDM] [or] [FKM]**-rubber O-rings.
- i. Handle: Lever type with locking device.

C. PVC Ball-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. GF Piping Systems: Georg Fischer LLC.
 - e. Hayward Flow Control; Hayward Industries, Inc.
 - f. IPEX USA LLC.
 - g. NIBCO INC.
 - h. Thermoplastic Valves, Inc.
 - i. **<Insert manufacturer's name>.**
2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - c. Body Material: ASTM D1784 PVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D1784 PVC compound.
 - g. Seat and Seals: **[EPDM] [or] [FKM]**-rubber O-rings.

D. PVC Swing-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Hayward Flow Control; Hayward Industries, Inc.
 - d. IPEX USA LLC.
 - e. Spears Manufacturing Company.
 - f. Thermoplastic Valves, Inc.
 - g. **<Insert manufacturer's name>.**
2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - c. Body Material: ASTM D1784 PVC compound.
 - d. Body Design: Bolted-bonnet type.
 - e. End Connections: Flanged.
 - f. Shaft: ASTM D1784 PVC compound.
 - g. Disc and Arm: ASTM D1784 PVC compounds.
 - h. Gasket and Seals: **[EPDM] [or] [FKM]** rubber.

E. PVC Diaphragm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.

- b. Asahi/America.
- c. Colonial Engineering, Inc.
- d. GF Piping Systems: Georg Fischer LLC.
- e. Hayward Flow Control; Hayward Industries, Inc.
- f. NIBCO INC.
- g. Spears Manufacturing Company.
- h. Thermoplastic Valves, Inc.
- i. **<Insert manufacturer's name>.**

2. Description:

- a. Standard: Comply with ASTM F1970.
- b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
- c. Body Material: ASTM D1784 PVC compound.
- d. Body Design: Bolted-bonnet type.
- e. End Connections for NPS 2 (DN 50) and Smaller: Detachable, socket.
- f. End Connections for NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Flanged.
- g. Diaphragm: **[EPDM] [FKM]** rubber.
- h. Seals: **[EPDM] [FKM]**-rubber O-rings.
- i. Handle: Wheel type.

2.8 PVDF VALVES

A. PVDF Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Asahi/America.
- b. GF Piping Systems: Georg Fischer LLC.
- c. NIBCO INC.
- d. Orion Fittings: A Watts Water Technologies Company.
- e. Plast-O-Matic Valves, Inc.
- f. Thermoplastic Valves, Inc.
- g. **<Insert manufacturer's name>.**

2. Description:

- a. Standard: MSS SP-122.
- b. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
- c. Body Material: ASTM D3222 PVDF resin.
- d. Body Design: Union type.
- e. End Connections: Detachable, butt or socket.
- f. Ball: ASTM D3222 PVDF resin.
- g. Port: Full.
- h. Seats: PTFE.
- i. Stem: ASTM D3222 PVDF resin.
- j. Stem Seals: FKM-rubber O-rings.
- k. Handle: Tee shaped.

B. PVDF Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. American Valve, Inc.
- b. Asahi/America.

- c. Colonial Engineering, Inc.
 - d. GF Piping Systems: Georg Fischer LLC.
 - e. Thermoplastic Valves, Inc.
 - f. **<Insert manufacturer's name>.**
2. Description:
- a. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - b. Body Material: ASTM D3222 PVDF resin.
 - c. Body Design: **[Lug] [or] [wafer]** type.
 - d. Seat: FKM rubber.
 - e. Disc: **[ASTM D3222 PVDF resin] <Insert material>.**
 - f. Stem: Stainless steel.
 - g. Stem Seals: FKM-rubber O-rings.
 - h. Handle: Lever type with locking device.
- C. PVDF Ball-Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Asahi/America.
 - b. GF Piping Systems: Georg Fischer LLC.
 - c. NIBCO INC.
 - d. Thermoplastic Valves, Inc.
 - e. **<Insert manufacturer's name>.**
2. Description:
- a. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - b. Body Material: ASTM D3222 PVDF resin.
 - c. Body Design: Union type.
 - d. End Connections: Detachable, socket.
 - e. Ball: ASTM D3222 PVDF resin.
 - f. Seat and Seals: FKM-rubber O-rings.
- D. PVDF Swing-Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. American Valve, Inc.
 - b. Asahi/America.
 - c. Thermoplastic Valves, Inc.
 - d. **<Insert manufacturer's name>.**
2. Description:
- a. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - b. Body Material: ASTM D3222 PVDF resin.
 - c. Body Design: Bolted-bonnet type.
 - d. End Connections: Flanged.
 - e. Shaft: ASTM D3222 PVDF resin.
 - f. Disc and Arm: ASTM D3222 PVDF resins.
 - g. Gasket and Seals: FKM rubber.

E. PVDF Diaphragm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. NIBCO INC.
 - e. Thermoplastic Valves, Inc.
 - f. **<Insert manufacturer's name>.**
2. Description:
 - a. Pressure Rating: **[150 psig (1035 kPa)] <Insert pressure> at [73 deg F (23 deg C)] <Insert temperature>.**
 - b. Body Material: ASTM D3222 PVDF resin.
 - c. Body Design: Bolted-bonnet type.
 - d. End Connections for NPS 2 (DN 50) and Smaller: Detachable, socket.
 - e. End Connections for NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Flanged.
 - f. Diaphragm: FKM rubber.
 - g. Seals: FKM-rubber O-rings.
 - h. Handle: Wheel type.

2.9 STAINLESS STEEL BALL VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 2. Marwin Valve; Richards Industries.
 3. Metso Automation USA Inc.
 4. Milwaukee Valve Company.
 5. NIBCO INC.
 6. Spirax Sarco Limited.
 7. **<Insert manufacturer's name>.**
- B. Description:
1. Standard: MSS SP-110.
 2. Minimum CWP Rating: 1000 psig (6895 kPa).
 3. Body Material: Stainless steel.
 4. Body Design: Three-piece bolted body type.
 5. End Connections: Socket welding.
 6. Seats: PTFE or TFE.
 7. Stem: Stainless steel.
 8. Ball: Stainless steel, vented.
 9. Port: Full.
 10. Handle: Lever type.

PART 3 - EXECUTION – NOT USED

1.

END OF SECTION 226713

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SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

Metal Labels for Equipment:

Manufacturers: Subject to compliance with requirements, **[provide products by the following]** [provide products by one of the following] **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

Brady Corporation.

- a. Brimar Industries, Inc.
- b. Carlton Industries, LP.
- c. Champion America.
- d. Craftmark Pipe Markers.
- e. emedco.
- f. Kolbi Pipe Marker Co.
- g. LEM Products Inc.
- h. Marking Services, Inc.
- i. Seton Identification Products; a Brady Corporation company.

Material and Thickness: Brass, 0.032-inch (0.8-mm) stainless steel, 0.025-inch (0.64-mm) aluminum, 0.032-inch (0.8-mm) anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, with predrilled or stamped holes for attachment hardware.

2. Letter and Background Color: As indicated for specific application under Part 3.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

General: Provide Flow Direction, Labeling for All Equipment, Equipment to be labeled by System, and space should be provided for PCC QR coding on all equipment.

2.2 WARNING SIGNS AND LABELS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. Brady Corporation.
 2. Carlton Industries, LP.
 3. National Marker Company.
 4. Seton Identification Products; a Brady Corporation company.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, with predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless steel rivets or self-taping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E and other applicable codes and standards.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. National Marker Company.
 - 3. Seton Identification Products; a Brady Corporation company.
- B. Material: Vinyl.
- C. Minimum Thickness: 0.005 inch (0.12 mm).
- D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
- F. Maximum Temperature: 160 deg F (70 deg C).
- G. Minimum Width: 2 inches (50 mm).

2.4 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Carlton Industries, LP.
 - 3. -
 - 4. Seton Identification Products; a Brady Corporation company.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
2. Lettering Size: Size letters in accordance with ASME A13.1 for piping. At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances.

2.5 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Carlton Industries, LP.
 3. Seton Identification Products; a Brady Corporation company.

Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware. Exterior Ductwork shall be provided with metal labeling.

- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- E. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless steel rivets or self-tapping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:
1. Duct size.
 2. Flow-Direction Arrows: Include flow-direction arrows on distribution ducts. Arrows may be either integral with label or may be applied separately.
 3. Lettering Size: Size letters in accordance with ASME A13.1 for piping. At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances.

2.6 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Carlton Industries, LP.
 3. Seton Identification Products; a Brady Corporation company.
- B. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.04-inch (1.0-mm) stainless steel, 0.024-inch (0.61-mm) aluminum, 0.031-inch (0.79-mm) or anodized aluminum, 0.031-inch (0.79-mm) minimum thickness, with predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass link chain or beaded chain.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Carlton Industries, LP
 3. Seton Identification Products; a Brady Corporation company.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Letter and Background Color: As indicated for specific application under Part 3.

2.8 CEILING MARKERS

- A. General: Provide standard color-coded, self-adhesive pressure sensitive punches, tape or plastic dots.
1. Tape Width: 1/2 inch.
 2. Clear Tape with black lettering mounted on 1-bar or access panel

PART 3 - EXECUTION

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
2. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.
 - b. Primary-secondary hydronic systems.
3. Balancing steam systems.
4. Testing, Adjusting, and Balancing Equipment:
 - a. Heat exchangers.
 - b. Motors.
 - c. Chillers.
 - d. Cooling towers.
 - e. Condensing units.
 - f. Boilers.
 - g. Heat-transfer coils.
5. Testing, adjusting, and balancing existing systems and equipment.
6. Sound tests.
7. Vibration tests.
8. Duct leakage tests.
9. Control system verification.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

- A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.4 ACTION SUBMITTALS

A. Sustainable Design Submittals:

1. Air-Balance Report: Documentation indicating that Work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. HVAC Flush Report: Documentation indicating that building HVAC system flush complies with Green Globes Section 3.2.4.4 "IAQ During Construction."

1. TAB Report: Documentation indicating that Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS(PSC to review with owner, typically independent)

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. TAB Specialists Qualifications: Certified by NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD 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.

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.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- 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 ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. 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.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. 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 the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 - 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning per the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

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 Total System Balance" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material 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. Cross-check 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 outdoor-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. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

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 total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

- b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses, close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. 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 occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
 - B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
 - C. Adjust air inlets and outlets for each space to indicated airflows.
 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
 - D. Verify final system conditions.
 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.
- ### 3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS
- A. Adjust the variable-air-volume systems as follows:
 1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
 2. Verify that the system is under static pressure control.

3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 1. Check liquid level in expansion tank.
 2. Check highest vent for adequate pressure.
 3. Check flow-control valves for proper position.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 5. Verify that motor starters are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.

3.8 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.
- B. Adjust the variable-flow hydronic system as follows:
 1. Verify that the differential-pressure sensor is located as indicated.
 2. Determine whether there is diversity in the system.
- C. For systems with no diversity:
 1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.

- 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
 5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 6. Prior to verifying final system conditions, determine the system differential-pressure set point.
 7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 8. Mark final settings and verify that all memory stops have been set.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
 10. Verify that memory stops have been set.
- D. For systems with diversity:
1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.

3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.

10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
13. Verify that memory stops have been set.

3.9 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first.
- B. Balance the secondary circuits after the primary circuits are complete.
- C. Adjust pumps to deliver total design gpm.
 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- D. Adjust flow-measuring devices installed in mains and branches to design water flows.
 1. Measure flow in main and branch pipes.
 2. Adjust main and branch balance valves for design flow.
 3. Re-measure each main and branch after all have been adjusted.
- E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 1. Measure flow at terminals.
 2. Adjust each terminal to design flow.
 3. Re-measure each terminal after it is adjusted.
 4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 5. Perform temperature tests after flows have been balanced.

- F. For systems with pressure-independent valves at terminals:
 - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.
 - G. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - 1. Measure and balance coils by either coil pressure drop or temperature method.
 - 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 - H. Verify final system conditions as follows:
 - 1. Re-measure and confirm that total water flow is within design.
 - 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - 3. Mark final settings.
 - I. Verify that memory stops have been set.
- 3.10 PROCEDURES FOR STEAM SYSTEMS
- A. Measure and record upstream and downstream pressure of each piece of equipment.
 - B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
 - C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
 - D. Check settings and operation of each safety valve. Record settings.
 - E. Verify the operation of each steam trap.
- 3.11 PROCEDURES FOR HEAT EXCHANGERS
- A. Adjust water flow to within specified tolerances.
 - B. Measure inlet and outlet water temperatures.
 - C. Measure inlet steam pressure.
 - D. Check settings and operation of safety and relief valves. Record settings.
- 3.12 PROCEDURES FOR MOTORS
- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
 - B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.13 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 - 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 - 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 - 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 - 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 - 6. Capacity: Calculate in tons of cooling.
 - 7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.14 PROCEDURES FOR COOLING TOWERS

- A. Balance total condenser-water flows to towers. Measure and record the following data:
 - 1. Condenser-water flow to each cell of the cooling tower.
 - 2. Entering- and leaving-water temperatures.
 - 3. Wet- and dry-bulb temperatures of entering air.
 - 4. Wet- and dry-bulb temperatures of leaving air.
 - 5. Condenser-water flow rate recirculating through the cooling tower.
 - 6. Cooling-tower spray pump discharge pressure.
 - 7. Condenser-water flow through bypass.
 - 8. Fan and motor operating data.

3.15 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.16 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
 - 1. Measure and record entering- and leaving-water temperatures.
 - 2. Measure and record water flow.
 - 3. Record relief valve pressure setting.
- B. Steam Boilers:
 - 1. Measure and record entering-water temperature.
 - 2. Measure and record feed water flow.
 - 3. Measure and record leaving-steam pressure and temperature.
 - 4. Record relief valve pressure setting.

3.17 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering- and leaving-water temperature.

2. Water flow rate.
 3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
 4. Dry-bulb temperature of entering and leaving air.
 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 6. Airflow.
- B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
 2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Airflow.
 3. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.
- 3.18 SOUND TESTS
- A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at 5 locations as designated by the Architect.
- B. Instrumentation:
1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
 2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).
 3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
 4. The accuracy of the sound-testing meter shall be plus or minus one decibel.
- C. Test Procedures:
1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
 2. Equipment should be operating at design values.
 3. Calibrate the sound-testing meter prior to taking measurements.
 4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
 5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
 6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
 7. Take readings no closer than 36 inches (900 mm) from a wall or from the operating equipment and approximately 60 inches (1500 mm) from the floor, with the meter held or mounted on a tripod.

8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.
 - d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.19 VIBRATION TESTS

- A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.
- B. Instrumentation:
 1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
 2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
 3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
 4. Verify calibration date is current for vibration meter before taking readings.
- C. Test Procedures:
 1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
 2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
 3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
 4. Record CPM or rpm.
 5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.
- D. Reporting:
 1. Report shall record location and the system tested.
 2. Include horizontal-vertical-axial measurements for tests.
 3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
 4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.20 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.

- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

3.21 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 - 1. Verify temperature control system is operating within the design limitations.
 - 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 - 3. Verify that controllers are calibrated and function as intended.
 - 4. Verify that controller set points are as indicated.
 - 5. Verify the operation of lockout or interlock systems.
 - 6. Verify the operation of valve and damper actuators.
 - 7. Verify that controlled devices are properly installed and connected to correct controller.
 - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.22 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. Verify the following:
 - 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 and the face velocity of filters and coils.
 - 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 rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.23 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.
 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 4. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.24 PROGRESS 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: Prepare monthly progress 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.

3.25 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.

8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches (mm), and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.

- f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat-coil static-pressure differential in inches wg (Pa).
 - g. Cooling-coil static-pressure differential in inches wg (Pa).
 - h. Heating-coil static-pressure differential in inches wg (Pa).
 - i. Outdoor airflow in cfm (L/s).
 - j. Return airflow in cfm (L/s).
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch (mm) o.c.
 - f. Make and model number.
 - g. Face area in sq. ft. (sq. m).
 - h. Tube size in NPS (DN).
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Average face velocity in fpm (m/s).
 - c. Air pressure drop in inches wg (Pa).
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
 - e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
 - f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
 - h. Water flow rate in gpm (L/s).
 - i. Water pressure differential in feet of head or psig (kPa).
 - j. Entering-water temperature in deg F (deg C).
 - k. Leaving-water temperature in deg F (deg C).
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig (kPa).
 - n. Refrigerant suction temperature in deg F (deg C).
 - o. Inlet steam pressure in psig (kPa).
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.

- d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h (kW).
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches (mm), and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
2. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm (L/s).
 - b. Entering-air temperature in deg F (deg C).
 - c. Leaving-air temperature in deg F (deg C).
 - d. Air temperature differential in deg F (deg C).
 - e. Entering-air static pressure in inches wg (Pa).
 - f. Leaving-air static pressure in inches wg (Pa).
 - g. Air static-pressure differential in inches wg (Pa).
 - h. Low-fire fuel input in Btu/h (kW).
 - i. High-fire fuel input in Btu/h (kW).
 - j. Manifold pressure in psig (kPa).
 - k. High-temperature-limit setting in deg F (deg C).
 - l. Operating set point in Btu/h (kW).
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h (kW).
- H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
1. Unit Data:
- a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h (kW).
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm (L/s).
 - i. Face area in sq. ft. (sq. m).
 - j. Minimum face velocity in fpm (m/s).
2. Test Data (Indicated and Actual Values):
- a. Heat output in Btu/h (kW).
 - b. Airflow rate in cfm (L/s).
 - c. Air velocity in fpm (m/s).
 - d. Entering-air temperature in deg F (deg C).
 - e. Leaving-air temperature in deg F (deg C).
 - f. Voltage at each connection.
 - g. Amperage for each phase.

- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches (mm), and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).
- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F (deg C).
 - d. Duct static pressure in inches wg (Pa).
 - e. Duct size in inches (mm).
 - f. Duct area in sq. ft. (sq. m).
 - g. Indicated airflow rate in cfm (L/s).
 - h. Indicated velocity in fpm (m/s).
 - i. Actual airflow rate in cfm (L/s).
 - j. Actual average velocity in fpm (m/s).
 - k. Barometric pressure in psig (Pa).
- K. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.

- h. Size.
 - i. Effective area in sq. ft. (sq. m).
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Air velocity in fpm (m/s).
 - c. Preliminary airflow rate as needed in cfm (L/s).
 - d. Preliminary velocity as needed in fpm (m/s).
 - e. Final airflow rate in cfm (L/s).
 - f. Final velocity in fpm (m/s).
 - g. Space temperature in deg F (deg C).
- L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Entering-water temperature in deg F (deg C).
 - c. Leaving-water temperature in deg F (deg C).
 - d. Water pressure drop in feet of head or psig (kPa).
 - e. Entering-air temperature in deg F (deg C).
 - f. Leaving-air temperature in deg F (deg C).
- M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm (L/s).
 - g. Water pressure differential in feet of head or psig (kPa).
 - h. Required net positive suction head in feet of head or psig (kPa).
 - i. Pump rpm.
 - j. Impeller diameter in inches (mm).
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig (kPa).
 - b. Pump shutoff pressure in feet of head or psig (kPa).
 - c. Actual impeller size in inches (mm).
 - d. Full-open flow rate in gpm (L/s).

- e. Full-open pressure in feet of head or psig (kPa).
- f. Final discharge pressure in feet of head or psig (kPa).
- g. Final suction pressure in feet of head or psig (kPa).
- h. Final total pressure in feet of head or psig (kPa).
- i. Final water flow rate in gpm (L/s).
- j. Voltage at each connection.
- k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.26 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Owner .
- B. Owner shall randomly select measurements, documented in the final report, to be rechecked. 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.
- C. If 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."
- D. 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.
- E. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 - 3. If the second verification also fails, Owner may contact AABC Headquarters regarding the AABC National Performance Guaranty.
- F. Prepare test and inspection reports.

3.27 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB 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 TAB during near-peak summer and winter conditions.

END OF SECTION 230593

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SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Direct Digital Control (DDC) system for HVAC.

1.2 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. BACnet Specific Definitions:
 - 1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.
 - 2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
 - 3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
 - 4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
- D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.
- F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- G. COV: Changes of value.
- H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
- I. Distributed Control: Processing of system data is decentralized, and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.
- J. E/P: Voltage to pneumatic.
- K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- L. HLC: Heavy load conditions.

- M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- N. I/P: Current to pneumatic.
- O. LAN: Local area network.
- P. LNS: LonWorks Network Services.
- Q. LON Specific Definitions:
 - 1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
 - 2. LonMark International: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
 - 3. LonTalk: An open standard protocol developed by Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
 - 4. LonWorks: Network technology developed by Echelon.
 - 5. Node: Device that communicates using CTA-709.1-D protocol and that is connected to a CTA-709.1-D network.
 - 6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
 - 7. Node ID: A unique 48-bit identifier assigned at factory to each CTA-709.1-D device. Sometimes called a "Neuron ID."
 - 8. Program ID: An identifier (number) stored in a device (usually, EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
 - 9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark for configuration properties.
 - 10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
 - 11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
 - 12. TP/FT-10: Free Topology Twisted Pair network defined by CTA-709.3 and is most common media type for a CTA-709.1-D control network.
 - 13. TP/XF-1250: High-speed, 1.25 Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" and typically used only to connect multiple TP/FT-10 networks.
 - 14. User-Defined Configuration Property Type (UCPT): Pronounced "u-keep-it." A Configuration Property format type that is defined by device manufacturer.
 - 15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.
- R. 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.

- S. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
 - T. Modbus TCP/IP: An open protocol for exchange of process data.
 - U. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
 - V. MTBF: Mean time between failures.
 - W. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
 - X. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
 - Y. Peer to Peer: Networking architecture that treats all network stations as equal partners.
 - Z. POT: Portable operator's terminal.
 - AA. RAM: Random access memory.
 - BB. RF: Radio frequency.
 - CC. Router: Device connecting two or more networks at network layer.
 - DD. Server: Computer used to maintain system configuration, historical and programming database.
 - EE. TCP/IP: Transport control protocol/Internet protocol.
 - FF. UPS: Uninterruptible power supply.
 - GG. USB: Universal Serial Bus.
 - HH. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
 - II. VAV: Variable air volume.
 - JJ. WLED: White light emitting diode.
- 1.3 PREINSTALLATION MEETINGS
- A. Preinstallation Conference: Conduct conference at Project site.
- 1.4 ACTION SUBMITTALS
- A. Multiple Submissions:
 - 1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
 - 2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
 - 3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.
 - B. Product Data:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
 - a. Workstations.
 - b. Printers.
 - c. Servers.
 - d. Gateways.
 - e. Routers.
 - f. Protocol analyzers.
 - g. DDC controllers.
 - h. Enclosures.
 - i. Electrical power devices.
 - j. UPS units.
 - k. Accessories.
 - l. Instruments.
 - m. Control dampers and actuators.
 - n. Control valves and actuators.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature to clearly cross reference specification and drawings that submittal is to cover.

C. Software Submittal:

Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.

1. Description and technical data of all software provided and cross-referenced to products in which software will be installed.
2. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
3. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
4. Listing and description of each engineering equation used with reference source.
5. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
6. Description of operator interface to alphanumeric and graphic programming.
7. Description of each network communication protocol.
8. Description of system database, including all data included in database, database capacity, and limitations to expand database.
9. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden, and system throughout.
10. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

1. General Requirements:
 - a. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.
 - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
 - c. Drawings Size: 30 inches by 42 inches.
2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:
 - a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork, and piping.
 - b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
 - c. Each desktop workstation network port, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
 - d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
 - e. Network communication cable and raceway routing.
 - f. Information, drawn to scale.
 - g. Proposed routing of wiring, cabling, conduit, and tubing; coordinated with building services for review before installation.
6. Schematic drawings for each controlled HVAC system indicating the following:
 - a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
 - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
 - c. A graphic showing location of control I/O in proper relationship to HVAC system.
 - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
 - e. Unique identification of each I/O that to be consistently used between different drawings showing same point.
 - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
 - g. Narrative sequence of operation.
 - h. Graphic sequence of operation, showing all inputs and output logical blocks.
7. Control panel drawings indicating the following:
 - a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
 - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
 - c. Front, rear, and side elevations and nameplate legend.
 - d. Unique drawing for each panel.

8. DDC system network riser diagram indicating the following:
 - a. Each device connected to network with unique identification for each.
 - b. Interconnection of each different network in DDC system.
 - c. For each network, indicate communication protocol, speed, and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
 - d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
9. DDC system electrical power riser diagram indicating the following:
 - a. Each point of connection to field power with requirements (volts/phase/hertz/ amperes/connection type) listed for each.
 - b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
 - c. Each product requiring power with requirements (volts/phase/hertz/ amperes/connection type) listed for each.
 - d. Power wiring type and size, race type, and size for each.
10. Monitoring and control signal diagrams indicating the following:
 - a. Control signal cable and wiring between controllers and I/O.
 - b. Point-to-point schematic wiring diagrams for each product.
 - c. Control signal tubing to sensors, switches, and transmitters.
 - d. Process signal tubing to sensors, switches, and transmitters.
 - e. Pneumatic main air and control signal tubing to pneumatic damper and valve actuators, pilot-positioners if applicable, and associated transducers.
11. Color graphics indicating the following:
 - a. Itemized list of color graphic displays to be provided.
 - b. For each display screen to be provided, a true color copy showing layout of pictures, graphics, and data displayed.
 - c. Intended operator access between related hierarchical display screens.
- E. System Description:
 1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
 2. Complete listing and description of each report, log and trend for format and timing, and events that initiate generation.
 3. System and product operation under each potential failure condition including, but not limited to, the following:
 - a. Loss of power.
 - b. Loss of network communication signal.
 - c. Loss of controller signals to inputs and outpoints.
 - d. Operator workstation failure.
 - e. Server failure.
 - f. Gateway failure.
 - g. Network failure.
 - h. Controller failure.
 - i. Instrument failure.
 - j. Control damper and valve actuator failure.
 4. Complete bibliography of documentation and media to be delivered to Owner.

5. Description of testing plans and procedures.
 6. Description of Owner training.
- F. Delegated Design Submittals: For DDC system products and installation indicated as being delegated.
1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
 2. Schedule and design calculations for control dampers and actuators.
 - a. Flow at Project design and minimum flow conditions.
 - b. Face velocity at Project design and minimum airflow conditions.
 - c. Pressure drop across damper at Project design and minimum airflow conditions.
 - d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
 - e. Maximum close-off pressure.
 - f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.
 - i. Actuator signal to control damper (on, close, or modulate).
 - j. Actuator position on loss of power.
 - k. Actuator position on loss of control signal.
 3. Schedule and design calculations for control valves and actuators.
 - a. Flow at Project design and minimum flow conditions.
 - b. Pressure-differential drop across valve at Project design flow condition.
 - c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
 - d. Design and minimum control valve coefficient with corresponding valve position.
 - e. Maximum close-off pressure.
 - f. Leakage flow at maximum system pressure differential.
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.
 - i. Actuator signal to control damper (on, close or modulate).
 - j. Actuator position on loss of power.
 - k. Actuator position on loss of control signal.
 4. Schedule and design calculations for selecting flow instruments.
 - a. Instrument flow range.
 - b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter, and output signal for remote control.
 - c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter, and output signal for remote control.
 - d. Pressure-differential loss across instrument at Project design flow conditions.
 - e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.
- G. Sustainable Design Submittals:
- H. LEED Submittals: As specified in Section 018113 "Sustainable Design Requirements."
1. Provide submittals for Building Product Disclosure and Optimization, Environmental Product Declarations, Option 1; Environmental Product Declaration.
 2. Provide submittals for Building Product Disclosure and Optimization, Environmental Product Declarations, Option 2; Embodied Carbon/LCA Action Plan.

3. Provide submittals for Building Product Disclosure and Optimization, Sourcing of Raw Materials.
4. Provide submittals for Building Product Disclosure and Optimization, Material Ingredients, Material Ingredient Reporting; Option 1.
5. Provide submittals for Building Product Disclosure and Optimization, Material Ingredients, Material Ingredient Reporting; Option 2.
6. Provide submittals for Low-Emitting Materials, Category C-Interior Adhesives and Sealants.
7. Product Data: For indicated products, indicating compliance with requirements for ENERGY STAR product labeling.
8. Product Data: For adhesives and sealants, indicating VOC content.
9. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plan drawings, reflected ceiling plans, or Building Information Model (BIM), and corresponding product installation details, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Qualification Statements:

1. Systems Provider's Qualification Data:

- a. Resume of project manager assigned to Project.
- b. Resumes of application engineering staff assigned to Project.
- c. Resumes of installation and programming technicians assigned to Project.
- d. Resumes of service technicians assigned to Project.
- e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity, and building's primary function.
- f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
- g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
- h. Owner contact information for past project including name, phone number, and email address.
- i. Contractor contact information for past project including name, phone number, and email address.
- j. Architect and Engineer contact information for past project including name, phone number, and email address.

2. Manufacturer's qualification data.

3. Testing agency's qualification data.

C. Welding certificates.

D. Product Certificates:

1. Data Communications Protocol Certificates:

- a. Certifying that each proposed DDC system component complies with ASHRAE 135.
- b. Certifying that each proposed DDC system component complies with LonWorks.

- E. Test and Evaluation Reports:
 - 1. Product Test Reports: For DDC system equipment and components, for tests performed by manufacturer .
 - 2. Preconstruction Test Reports: For each separate test performed.
- F. Source Quality-Control Reports: For DDC system equipment and components.
- G. Field Quality-Control Reports: For DDC system equipment and components.
- H. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For DDC system.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
 - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
 - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - g. Engineering, installation, and maintenance manuals that explain how to do the following:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
 - h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
 - i. Backup copy of graphic files, programs, and databases on electronic media.
 - j. List of recommended spare parts with part numbers and suppliers.
 - k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 - m. Licenses, guarantees, and warranty documents.
 - n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
 - o. Owner training materials.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials and parts to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list to be indicated for each year.
- C. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.
- D. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:
 - 1. Network Controller: One.
 - 2. Programmable Application Controller: One.
 - 3. Application-Specific Controller: One.
 - 4. General-Purpose Relay: One.
 - 5. Multifunction Time-Delay Relay: One.
 - 6. Latching Relay: One.
 - 7. Current-Sensing Relay: One.
 - 8. Combination On-Off Status Sensor and On-Off Relay: One.
 - 9. Transformer: One.
 - 10. DC Power Supply: One.

1.8 QUALITY ASSURANCE

- A. DDC System Manufacturer Qualifications:
 - 1. Nationally recognized manufacturer of DDC systems and products.
 - 2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
 - 3. DDC systems and products that have been successfully tested and in use on at least five past projects.
 - 4. Having complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
 - 5. Having full-time in-house employees for the following:
 - a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing, and quality control.
 - d. Technical support for DDC system installation training, commissioning, and troubleshooting of installations.
 - e. Owner operator training.
- B. DDC System Provider Qualifications:
 - 1. Authorized representative of, and trained by, DDC system manufacturer.
 - 2. In-place facility located within 100 miles of Project.
 - 3. Demonstrate past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
 - 4. Demonstrate past experience on five projects of similar complexity, scope, and value.
 - 5. Demonstrate past experience of each person assigned to Project.
 - 6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
 - 7. Service and maintenance staff assigned to support Project during warranty period.
 - 8. Product parts inventory to support ongoing DDC system operation for a period of not less than five years after Substantial Completion.

9. DDC system manufacturer's backing to take over execution of the Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.
 - C. Testing Agency Qualifications: Member company of NETA.
 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
 - D. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
 1. AWS D1.1/D1.1M.
 2. AWS D1.2/D1.2M.
 3. AWS D1.3/D1.3M.
 4. AWS D1.4/D1.4M.
 - E. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.
- 1.9 WARRANTY
- A. Special Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
 1. Adjust, repair, or replace failures at no additional cost or reduction in service to Owner.
 2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
 - a. Install updates only after receiving Owner's written authorization.
 3. Perform warranty service during normal business hours and commence within 8 24 hours of Owner's warranty service request.
 4. Warranty Period: Two year(s) from date of Substantial Completion.

For Gateway: Two -year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following:
 1. Adhesives: VOC content and emissions evaluation.
 2. Chemical content.

2.2 DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. ABB, Electrification Business.
 2. Alerton Inc.
 3. Automated Logic Corporation.
 4. Delta Controls Inc.
 5. Distech Controls.
 6. Honeywell International Inc.
 7. Johnson Controls, Inc.
 8. KMC Controls, Inc.
 9. Reliable Controls Corporation.
 10. Schneider Electric USA, Inc.

11. Siemens Industry, Inc., Building Technologies Division.
12. Trane.

2.3 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
 1. DDC system consisting of high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 WEB ACCESS

- A. DDC system to be web based or web compatible.
 1. Web-Based Access to DDC System:

DDC system software based on server thin-client architecture, designed around open standards of web technology. DDC system server accessed using a web browser over DDC system network, using Owner's LAN, and remotely over Internet through Owner's LAN.

- a. Intent of thin-client architecture is to provide operators complete access to DDC system via a web browser. No special software other than a web browser is required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
 - b. Password-protected web access.
2. Web-Compatible Access to DDC System:
 - a. Workstation and or server to perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
 - b. DDC system to support web browser access to building data. Operator using a standard web browser is able to access control graphics and change adjustable set points.
 - c. Password-protected web access.

2.5 PERFORMANCE REQUIREMENTS

- A. Delivery of Selected Control Devices: Deliver to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.
- B. Delegated Design, Qualified Professional Engineer: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design DDC system to satisfy requirements indicated.
- C. Delegated Design, Qualified Professional: Engage a qualified professional to design DDC system to satisfy requirements indicated.
 1. System Performance Objectives:
 - a. DDC system manages HVAC systems.
 - b. DDC system operates HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
 - c. DDC system responds to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.

- d. DDC system operates while unattended by an operator and through operator interaction.
 - e. DDC system records trends and transactions of events and produces report information such as performance, energy, occupancies, and equipment operation.
- D. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths complying with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- E. DDC System Speed:
 - 1. Response Time of Connected I/O:
 - a. Update AI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
 - b. Update BI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
 - c. AO points connected to DDC system to begin to respond to controller output commands within two second(s). Global commands to also comply with this requirement.
 - d. BO point values connected to DDC system to respond to controller output commands within two second(s). Global commands to also comply with this requirement.
 - 2. Display of Connected I/O:
 - a. Update and display analog point COV connected to DDC system at least every five seconds for use by operator.
 - b. Update and display binary point COV connected to DDC system at least every five seconds for use by operator.
 - c. Update and display alarms of analog and digital points connected to DDC system within 15 seconds of activation or change of state.
 - d. Update graphic display refresh within four seconds.
 - e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations to not exceed graphic refresh rate indicated.
- F. Network Bandwidth: Design each network of DDC system to include spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions. Minimum spare bandwidth as follows:
 - 1. Level 1 Networks: 20 .
 - 2. Level 2 Networks: 20 .
 - 3. Level 3 Networks: 10 .
- G. DDC System Data Storage:
 - 1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends, and other information indicated.
 - 2. Local Storage:
 - a. Provide server with data storage indicated. Server(s) to use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

3. Cloud Storage:
 - a. Provide application-based and web browser interfaces to configure, upload, download, and manage data and to service plan with storage adequate to store all data for term indicated. Cloud storage uses IT industry standard database platforms and is capable of functions described in "DDC Data Access" Paragraph.
- H. DDC Data Access:
 1. When logged into the system, operator able to also interact with any DDC controllers connected to DDC system as required for functional operation of DDC system.
 2. Use for application configuration; for archiving, reporting, and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
- I. Future Expandability:
 1. DDC system size is expandable to an ultimate capacity of at least 1.5 times total I/O points indicated.
 2. Design and install system networks to achieve ultimate capacity with only addition of DDC controllers, I/O, and associated wiring and cable. Design and install initial network infrastructure to support ultimate capacity without having to remove and replace portions of network installation.
 3. Operator interfaces installed initially do not require hardware and software additions and revisions for system when operating at ultimate capacity.
- J. Input Point Values Displayed Accuracy: Meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.
 1. Energy:
 - a. Thermal: Within 3 percent of reading.
 - b. Electric Power: Within 1 percent of reading.
 - c. Requirements indicated on Drawings for meters not supplied by utility.
 2. Flow:
 - a. Air: Within 5 percent of design flow rate.
 - b. Air (Terminal Units): Within 5 percent of design flow rate.
 - c. Fuel Oil: Within 5 percent of design flow rate.
 - d. Natural Gas: Within 5 percent of design flow rate.
 - e. Water: Within 5 percent of design flow rate.
 - f. Steam: Within 5 percent of design flow rate.
 3. Gas:
 - a. Carbon Dioxide: Within 50 ppm.
 - b. Carbon Monoxide: Within 5 percent of reading.
 - c. Oxygen: Within 5 percent of reading.
 - d. Refrigerant: Within 5 percent of reading.
 - e. VOCs: Within 5 percent of reading.
 4. Moisture (Relative Humidity):
 - a. Air: Within 5 percent RH.
 - b. Space: Within 2 percent RH.
 - c. Outdoor: Within 5 percent RH.
 5. Level: Within 5 percent of reading.

6. Pressure:
 - a. Air, Ducts and Equipment: 1 percent of instrument range.
 - b. Space: Within 0.5 percent of instrument range.
 - c. Water: Within 0.5 percent of instrument range.
 - d. Steam: Within 0.5 percent of instrument range.
7. Speed: Within 5 percent of reading.
8. Temperature, Dew Point:
 - a. Air: Within 1 deg F (0.5 deg C).
 - b. Space: Within 0.5 deg F (0.2 deg C).
 - c. Outdoor: Within 3 deg F (1.5 deg C).
9. Temperature, Dry Bulb:
 - a. Air: Within 1 deg F (0.5 deg C).
 - b. Space: Within 0.5 deg F (0.2 deg C).
 - c. Outdoor: Within 2 deg F (1 deg C).
 - d. Chilled Water: Within 0.5 deg F (0.2 deg C).
 - e. Condenser Water: Within 0.5 deg F (0.2 deg C).
 - f. Heating Hot Water: Within 0.5 deg F (0.2 deg C).
 - g. Energy Recovery Runaround Liquid: Within 0.5 deg F (0.2 deg C).
 - h. Steam: Within 2 deg F (1 deg C).
 - i. Temperature Difference: Within 0.25 deg F (0.15 deg C).
 - j. Other Temperatures Not Indicated: Within 1 deg F (0.5 deg C).
10. Temperature, Wet Bulb:
 - a. Air: Within 1 deg F (0.5 deg C).
 - b. Space: Within 1 deg F (0.5 deg C).
 - c. Outdoor: Within 2 deg F (1 deg C).
11. Vibration: Within 5 percent of reading.
- K. Precision of I/O Reported Values: Values reported in database and displayed to have following precision:
 1. Current:
 - a. Milliampere: Nearest 1/100th of a milliampere.
 - b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.
 2. Energy:
 - a. Electric Power:
 - 1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
 - 2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
 - 3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.
 - b. Fuel Oil (Usage): For gallons, nearest 1/10th of a gallon up to 100 gal.; nearest gallon for above 100 gal. (For liters, nearest 1/10th of a liter up to 1000 L; nearest liter for above 1000 L).
 - c. Natural Gas (Usage): Nearest 1/10th of a unit (cubic feet, MCF, therm) up to 100 units; nearest unit for above 100 units (For MCM, nearest 1/10th of an MCM up to 1000 MCM; nearest MCM for above 1000 MCM).

- d. Thermal, Rate:
 - 1) Heating: For British thermal units per hour, nearest British thermal unit per hour up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For MBh, round to nearest MBh up to 1000 MBh; nearest 10 MBh between 1000 and 10,000 MBh; nearest 100 MBh above 10,000 MBh (For watts, nearest watt up to 1000 W; for kilowatts, round to nearest kilowatt up to 1000 kW; nearest 10 kW between 1000 and 10 000 kW; nearest 100 kW for above 10 000 kW).
 - 2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons (For watts, nearest watt up to 1000 W; for kilowatts, round to nearest kilowatt up to 1000 kW; nearest 10 kW between 1000 and 10 000 kW; nearest 100 kW for above 10 000 kW).
 - e. Thermal, Usage:
 - 1) Heating: For British thermal unit, nearest British thermal unit up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For MBtu, round to nearest MBtu up to 1000 MBtu; nearest 10 MBtu between 1000 and 10,000 MBtu; nearest 100 MBtu above 10,000 MBtu (For watt-hours, nearest watt-hour up to 1000 Wh; for kilowatt-hours, round to nearest kilowatt-hour up to 1000 kWh; nearest 10 kWh between 1000 and 10 000 kWh; nearest 100 kWh for above 10 000 kWh).
 - 2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons (For watt-hours, nearest watt-hour up to 1000 Wh; for kilowatt-hours, round to nearest kilowatt-hour up to 1000 kWh; nearest 10 kWh between 1000 and 10 000 kWh; nearest 100 kWh for above 10 000 kWh).
3. Flow:
- a. Air: Nearest 1/10th of a cubic feet per minute through 100 cfm; nearest cubic feet per minute between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm (Nearest 1/10th of a liter per second through 100 L/s; nearest liter per second between 100 and 1000 L/s; nearest 10 L/s between 1000 and 10 000 L/s; nearest 100 L/s above 10 000 L/s).
 - b. Fuel Oil: Nearest 1/10th of a gallon per minute through 100 gpm; nearest gallon per minute between 100 and 1000 gpm (Nearest 1/10th of a liter per second through 100 L/s; nearest liter per second between 100 and 1000 L/s).
 - c. Natural Gas: Nearest 1/10th of a cubic feet per hour through 100 cfh; nearest cubic feet per hour between 100 and 1000 cfh; nearest 10 cfh between 1000 and 10,000 cfh; nearest 100 cfh above 10,000 cfh (Nearest 1/100th of a cubic meter per hour through 100 cmh; nearest 1/10th cmh between 100 and 1000 cmh; nearest cubic meter per hour above 1000 cmh).
 - d. Water: Nearest 1/10th of a gallon per minute through 100 gpm; nearest gallon per minute between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm (Nearest 1/10th of a liter per second through 100 L/s; nearest liter per second between 100 and 1000 L/s; nearest 10 L/s between 1000 and 10 000 L/s; nearest 100 L/s above 10 000 L/s).
 - e. Steam: Nearest 1/10th of a pound per hour through 100 lb/h; nearest pound per hour between 100 and 1000 lb/h; nearest 10 lb/h above 1000 lb/h (Nearest 1/10th of a liter per second through 100 L/s; nearest liter per second between 100 and 1000 L/s; nearest 10 L/s above 1000 L/s).

4. Gas:
 - a. Carbon Dioxide (ppm): Nearest ppm.
 - b. Carbon Monoxide (ppm): Nearest ppm.
 - c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
 - d. Refrigerant (ppm): Nearest ppm.
 - e. Volatile Organic Compounds (ppm): Nearest ppm
5. Moisture (Relative Humidity):
 - a. Relative Humidity (Percentage): Nearest 1 percent.
6. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches (Nearest 1/100th of a millimeter through 10 mm; nearest 1/10th of a millimeter between 10 and 100 mm; nearest millimeter above 100 mm).
7. Speed:
 - a. Rotation (rpm): Nearest 1 rpm.
 - b. Velocity: Nearest 1/10th of feet per minute through 100 fpm; nearest feet per minute between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm (Nearest 1/100th of a meter per second through 10 m/s; nearest 1/10th of a meter per second above 10 m/s).
8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
9. Pressure:
 - a. Air, Ducts and Equipment: Nearest 1/10th of an inch water closet (Nearest pascal up to 1000 Pa; nearest 10 Pa above 1000 Pa).
 - b. Space: Nearest 1/100th of an inch water closet (Nearest 1/10th of a pascal).
 - c. Steam: Nearest 1/10th of pounds per square inch gauge through 100 psig; nearest pounds per square inch gauge above 100 psig (Nearest kilopascal through 1000 kPa; nearest 10 kPa above 1000 kPa).
 - d. Water: Nearest 1/10 of a pound per square inch gauge through 100 psig; nearest pound per square inch gauge above 100 psig (Nearest kilopascal through 1000 kPa; nearest 10 kPa above 1000 kPa).
10. Temperature:
 - a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
 - b. Outdoor: Nearest degree.
 - c. Space: Nearest 1/10th of a degree.
 - d. Chilled Water: Nearest 1/10th of a degree.
 - e. Condenser Water: Nearest 1/10th of a degree.
 - f. Heating Hot Water: Nearest degree.
 - g. Heat Recovery Runaround: Nearest 1/10th of a degree.
 - h. Steam: Nearest degree.
11. Vibration: Nearest 1/10th of an inch per second (Nearest 1/10th of a millimeter per second).
12. Voltage: Nearest 1/10 V up to 100 V; nearest volt above 100 V.
- L. Control Stability: Control variables indicated within the following limits:
 1. Flow:
 - a. Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.
 - b. Air, Terminal Units: Within 10 percent of design flow rate.
 - c. Water: Within 5 percent of design flow rate.

- d. Steam: Within 5 percent of design flow rate.
- 2. Gas:
 - a. Carbon Dioxide: Within 50 ppm.
 - b. Carbon Monoxide: Within 5 percent of reading.
 - c. Oxygen: Within 5 percent of reading.
- 3. Moisture (Relative Humidity):
 - a. Air: Within 5 percent RH.
 - b. Space: Within 5 percent RH.
 - c. Outdoor: Within 5 percent RH.
- 4. Level: Within 5 percent of reading.
- 5. Pressure:
 - a. Air, Ducts and Equipment: 1 percent of instrument range.
 - b. Space: Within 1 percent of instrument range.
 - c. Water: Within 1 percent of instrument range.
 - d. Steam: Within 1 percent of instrument range.
- 6. Temperature, Dew Point:
 - a. Air: Within 1 deg F (0.5 deg C).
 - b. Space: Within 1 deg F (0.5 deg C).
- 7. Temperature, Dry Bulb:
 - a. Air: Within 2 deg F (1 deg C).
 - b. Space: Within 2 deg F (1 deg C).
 - c. Chilled Water: Within 1 deg F (0.5 deg C).
 - d. Condenser Water: Within 1 deg F (0.5 deg C).
 - e. Heating Hot Water: Within 2 deg F (1 deg C).
 - f. Energy Recovery Runaround Liquid: Within 1 deg F (0.5 deg C).
- 8. Temperature, Wet Bulb:
 - a. Air: Within 1 deg F (0.5 deg C).
 - b. Space: Within 1 deg F (0.5 deg C).
- M. Environmental Conditions for Controllers, Gateways, and Routers:
 - 1. Products to operate without performance degradation under ambient environmental temperature, pressure, and humidity conditions encountered for installed location.
 - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated, cooled, and ventilated as required by product and application.
 - 2. Protect products with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House products not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location dictates the following NEMA 250 enclosure requirements:
 - a. Outdoors, Protected: Type 3 .
 - b. Outdoors, Unprotected: Type 4.
 - c. Indoors, Heated with Filtered Ventilation: Type 1.
 - d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
 - e. Indoors, Heated and Air-Conditioned: Type 1.

- f. Mechanical Equipment Rooms:
 - 1) Chiller and Boiler Rooms: Type 12.
 - 2) Air-Moving Equipment Rooms: Type 1.
 - g. Localized Areas Exposed to Washdown: Type 4 .
 - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: **Type 2** .
 - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4 .
 - j. Hazardous Locations: Explosion-proof rating for condition.
- N. Environmental Conditions for Instruments and Actuators:
- 1. Instruments and actuators to operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure is internally insulated, electrically heated[, **cooled**], and ventilated as required by instrument and application.
 - 2. Protect instruments, actuators, and accessories with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House instruments and actuators not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location is to dictate the following NEMA 250 enclosure requirements:
 - a. Outdoors, Protected: Type 2 .
 - b. Outdoors, Unprotected: Type 4 .
 - c. Indoors, Heated with Filtered Ventilation: Type 1 .
 - d. Indoors, Heated with Non-Filtered Ventilation: Type 2 .
 - e. Indoors, Heated and Air-conditioned: Type 1.
 - f. Mechanical Equipment Rooms:
 - 1) Chiller and Boiler Rooms: Type 12 .
 - 2) Air-Moving Equipment Rooms: Type 1 .
 - g. Localized Areas Exposed to Washdown: Type 4.
 - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2 .
 - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
 - j. Hazardous Locations: Explosion-proof rating for condition.
- O. DDC System Reliability:
- 1. Design, install, and configure DDC controllers, gateways, routers, to yield a MTBF of at least 20,000 hours, based on a confidence level of at least 90 percent. MTBF value includes any failure for any reason to any part of products indicated.
 - 2. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment being controlled, operational, and under automatic control.
 - 3. See Drawings for critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated.

P. Electric Power Quality:

1. Power-Line Surges:

- a. Protect DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.1 and IEEE C62.41.2.
- b. Do not use fuses for surge protection.
- c. Test protection in the normal mode and in the common mode, using the following two waveforms:
 - 1) 10-by-1000-microsecond waveform with a peak voltage of 1500 V and a peak current of 60 A.
 - 2) 8-by-20-microsecond waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

- a. Protect DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner are as follows:
 - 1) At 85 percent load, output voltage to not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
 - 2) During load changes from zero to full load, output voltage to not deviate by more than 3 percent of nominal.
 - 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
 - 4) Total harmonic distortion to not exceed 3percent at full load.
3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products to not fail due to ground fault condition.

Q. Backup Power Source:

1. Serve DDC system products that control HVAC systems and equipment served by a backup power source also from a backup power source.

R. UPS:

1. DDC system products powered by UPS units are to include the following:
 - a. Servers.
 - b. Gateways.
 - c. DDC controllers, except application-specific controllers.
 - d. Desktop workstations.
2. DDC system instruments and actuators powered by UPS units are to include the following:
 - a. Instruments: Where indicated on Drawings; where associated with the following systems controlled by DDC system:
 - b. Damper Actuators: where associated with the following systems controlled by DDC system:
 - 1) **<Insert list of systems>.**
 - c. Valve Actuators: where associated with the following systems controlled by DDC system:
 - 1) **<Insert list of systems>.**

S. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems are to automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.6 PANEL-MOUNTED, MANUAL OVERRIDE SWITCHES

A. Manual Override of Control Dampers:

1. Include panel-mounted, two-position, selector switch for each automatic control damper being controlled by DDC controller.
2. Label each switch with damper designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to damper.
4. With switch in "Auto" position, control signal to damper actuator with control loop output signal from DDC controller.
5. With switch in "Manual" position, control signal to damper actuator at panel with either an integral or a separate switch to include local control.
 - a. For Binary Control Dampers: Manual two-position switch with "Close" and "Open" switch positions indicated. With switch in "Close" position, close damper. With switch in "Open" position, open damper.
 - b. For Analog Control Dampers: A gradual switch with "Close" and "Open" switch limits indicated. Operator switches knob to adjust damper to any position from close to open.
6. DDC controller to monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller to signal an override condition to alert operator that damper is under manual, not automatic, control.
7. Configure manual override switches to allow operator to manually operate damper while at panel without DDC controller **[installed] [and] [operational]**.
8. Terminal equipment including **[VAV units,] [fan-coil units,] [and] [unit heaters]** do not require manual override unless otherwise indicated by sequence of operation.

B. Manual Override of Control Valves:

1. Include panel-mounted, two-position, selector switch for each automatic control valve being controlled by DDC controller.
2. Label each switch with valve designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to valve.
4. With switch in "Auto" position, control signal to valve actuator with a control loop output signal from DDC controller.
5. With switch in "Manual" position, control signal to valve actuator at panel with either an integral or a separate switch to include local control.
 - a. For Binary Control Valves: Manual two-position switch with "Close" and "Open" switch positions indicated. With switch in "Close" position, close valve. With switch in "Open" position, open valve.
 - b. For Analog Control Valves: A gradual switch with "Open" and "Close" switch limits indicated. Operator rotates switch knob to adjust valve to any position from close to open.
6. DDC controller to monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller to signal an override condition to alert operator that valve is under manual, not automatic, control.

7. Configure manual override switches to allow operator to manually operate valve while at panel without DDC controller [**installed**] [**and**] [**operational**].
8. Terminal equipment including [**VAV units,**] [**fan-coil units,**] [**and**] [**unit heaters**] do not require manual override unless otherwise indicated by sequence of operation.

2.7 SYSTEM ARCHITECTURE

- A. System architecture consisting of no more than two or three levels of LANs.
 1. Level 2 LAN: Connect network controllers and operator workstations.
 2. Level 1 or Level 2 LAN: Connect [**Level 1**] [**or**] [**Level 2**] programmable application controllers to other programmable application controllers and to network controllers.
 3. Level 2 or Level 3 LAN: Connect [**Level 2**] [**or**] [**Level 3**] application-specific controllers to [**programmable application controllers and to network controllers**] [**application-specific controllers**].
- B. Minimum Data Transfer and Communication Speed:
 1. LAN Connecting Operator Workstations and Network Controllers: [**100**] [**10**] [**2.5**] [**1.25**] **<Insert value>** Mbps.
 2. LAN Connecting Programmable Application Controllers: [**1000**] [**100**] **<Insert value>** kbps.
 3. LAN Connecting Application-Specific Controllers: [**115,000**] [**76,800**] [**38,400**] [**19,200**] **<Insert value>** bps.
- C. Provide dedicated[**and separated**] DDC system LANs that are not shared with other building systems and tenant data and communication networks.
- D. Provide modular system architecture with inherent ability to expand to not less than [**1.25**] [**1.5**] [**two**] **<Insert number>** times system size indicated with no impact to performance indicated.
- E. Configure architecture to [**eliminate**] [**or**] [**minimize**] need to remove and replace existing network equipment for system expansion.
- F. Make number of LANs and associated communication transparent to operator. Configure all I/O points residing on any LAN to be capable of global sharing between all system LANs.
- G. Design system to eliminate dependence on any single device for system alarm reporting and control execution. Design each controller to operate independently by performing own control, alarm management, and historical data collection.
- H. Special Network Architecture Requirements:
 1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling-system air-handling unit(s). Basically, create DDC system LAN that aligns with air-handling system being controlled.
 2. **<Insert additional requirements>**.

2.8 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator able to access entire DDC system through any of multiple means including, but not limited to, the following:
 1. Desktop and portable workstation with hardwired connection through LAN port.
 2. Portable operator terminal with hardwired connection through LAN port.
 3. Portable operator workstation with wireless connection through LAN router.
 4. Mobile device and application with secured wireless connection through LAN router or cellular data service.

5. Remote connection through web access.
- B. Make access to system, regardless of operator means used, transparent to operator.
- C. Network Ports: For hardwired connection of desktop or portable workstation. Network port easily accessible, properly protected, clearly labeled, and installed at the following locations:
 1. Each mechanical equipment room.
 2. Each boiler room.
 3. Each chiller room.
 4. Each outdoor on-grade yard and elevated platform with equipment connected to DDC system.
 5. Each different roof level with roof-mounted equipment connected to DDC system.
 6. Security system command center.
 7. Fire-alarm system command center.
 8. **<Insert additional locations>**.
- D. Desktop Workstations:
 1. Connect **[Owner-furnished]** desktop workstation(s) to DDC system Level 1 LAN through a communications port directly on LAN or through a communications port on a DDC controller.
 2. Able to communicate with any device located on any DDC system LAN.
- E. Portable Workstations:
 1. Connect **[Owner-furnished]** portable workstation(s) to DDC system Level 1 LAN through a communications port directly on LAN or through a communications port on a DDC controller.
 2. Able to communicate with any device located on any DDC system LAN.
 3. Connect to DDC system **[Level 2]** **[or]** **[Level 3]** LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
 4. Connect to system through a wireless router connected to Level 1 LAN.
 5. Connect to system through a cellular broadband data service.
 6. Portable workstation able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
 7. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
 8. Have dynamic graphic displays that are identical to desktop workstations.
- F. POT:
 1. Connect DDC controller through a communications port local to controller.
 2. Able to communicate with any DDC system controller that is directly connected **[or with LAN]** **[or connected to DDC system]**.
- G. Mobile Device (Tablet and Smart Phone):
 1. Connect Owner-furnished mobile devices to system through a wireless router connected to LAN **[and cellular data service]**.
 2. Able to communicate with any DDC controller connected to DDC system using **[dedicated application]** **[and]** **[secure web access]**.
- H. Critical Alarm Reporting:
 1. Send operator-selected critical alarms to notify operator of critical alarms that require immediate attention.
 2. Send alarm notification to multiple recipients that are assigned for each alarm.

3. Notify recipients by any or all means, including email, text message, and prerecorded phone message to mobile and landline phone numbers.
- I. Simultaneous Operator Use: Capable of accommodating up to **[five] [10] [20] <Insert number>** simultaneous operators that are accessing DDC system through any of operator interfaces indicated.

2.9 NETWORKS

- A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:
 1. ATA 878.1, ARCNET.
 2. CTA-709.1-D.
 3. IP.
 4. ISO/IEC/IEEE 8802-3, Ethernet.
 5. **<Insert type>**.
- B. Acceptable networks for connecting programmable application controllers include the following:
 1. ATA 878.1, ARCNET.
 2. CTA-709.1-D.
 3. IP.
 4. ISO/IEC/IEEE 8802-3, Ethernet.
 5. **<Insert type>**.
- C. Acceptable networks for connecting application-specific controllers include the following:
 1. ATA 878.1, ARCNET.
 2. CTA-709.1-D.
 3. TIA 485-A.
 4. IP.
 5. ISO/IEC/IEEE 8802-3, Ethernet.
 6. **<Insert type>**.

2.10 NETWORK COMMUNICATION PROTOCOL

- A. Use network communication protocol(s) that are open to Owner and available to other companies for use in making future modifications to DDC system.
- B. ASHRAE 135 Protocol:
 1. Use ASHRAE 135 communication protocol as sole and native protocol used throughout entire DDC system.
 2. DDC system to not require use of gateways except to integrate HVAC equipment and other building systems and equipment; not required to use ASHRAE 135 communication protocol.
 3. If used, gateways to connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
 4. Use operator workstations, controllers, and other network devices that are tested and listed by BTL.
- C. CTA-709.1-D Protocol:
 1. Open implementation of LonWorks technology using CTA 709.1-D communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for communication throughout DDC system.

2. Use LNS for all network management including addressing and binding of network variables.
 - a. Submit final LNS database with Project closeout submittals.
 - b. All devices are to be online and commissioned into LNS database.
3. Use CTA-709.1-D protocol for all connected device. Install so SCPT output from any node on network can be bound to any other node in the domain.

D. Industry Standard Protocols:

1. Use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
 - a. ASHRAE 135.
 - b. CTA-709.1-D.
 - c. Modbus Application Protocol Specification V1.1b3.
 - d. **<Insert standard protocol>**.
2. Operator workstations **[and network controllers]**are to communicate through **[ASHRAE 135] [or] [CTA-709.1-D]** protocol.
3. Provide portions of DDC system networks using ASHRAE 135 communication protocol as an open implementation of network devices complying with ASHRAE 135. Use network devices that are tested and listed by BTL.
4. Provide portions of DDC system networks using CTA-709.1-D communication protocol as an open implementation of LonWorks technology using CTA-709.1-D communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for DDC system.
5. Provide portions of DDC system networks using Modbus Application Protocol Specification V1.1b3 communication protocol as an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b3.
6. Use gateways to connect networks and network devices with different protocols.

2.11 DDC SYSTEM WIRELESS NETWORKS

- A. Use **[Zigbee] [or] [an open industry standard and technology used by multiple DDC system manufacturers] <Insert wireless technology>** technology to create a wireless mesh network to provide wireless connectivity for network devices at multiple system levels including communications from programmable application controllers and application-specific controllers to temperature sensors and from network controllers to programmable application controllers and application-specific controllers.
- B. Design and install wireless networks to comply with DDC system performance requirements indicated using wireless network devices that can co-exist on same network with hardwired devices.
- C. Provide hardwired controllers capable of retrofitting to wireless devices with no special software.
- D. Provide a wireless coordinator for wireless interface between programmable application controllers, application-specific controllers, and network controllers.
- E. Wireless Coordinators:
 1. Use for initiation and formation of each wireless mesh network.
 2. Use direct-sequence spread spectrum RF technology.
 3. Operate on 2.4 GHz ISM Band.
 4. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
 5. FCC compliant to 47 CFR 15, Subpart B, Class A.

6. Operate as a bidirectional transceiver with sensors and routers to confirm and synchronize data transmission.
 7. Capable of communication with sensors and routers up to a maximum distance of 250 ft. (76 m) in line of sight.
 8. Include visual indicators to provide diagnostic information required for operator verification of operation.
- F. Wireless Routers:
1. Use wireless routers with any controller to provide a wireless interface to a network controller, through a wireless coordinator.
 2. Use direct-sequence spread spectrum RF technology.
 3. Operate on 2.4 GHz ISM Band.
 4. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
 5. FCC compliant to 47 CFR 15, Subpart B, Class A.
 6. Operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
 7. Capable of communication with other mesh network devices at a maximum distance of 250 ft. (76 m) in line of sight.
 8. Include indication for use in commissioning and troubleshooting.
- G. Wireless Temperature Sensors:
1. Wireless temperature sensors to sense and transmit room temperatures, temperature set point, room occupancy notification, and low battery condition to an associated router.
 2. Use direct-sequence spread spectrum RF technology.
 3. Operate on 2.4 GHz ISM Band.
 4. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
 5. FCC compliant to 47 CFR 15, Subpart B, Class A.
 6. Include set-point adjustment between 55 to 85 deg F (13 to 30 deg C).
 7. Configure so multiple sensors can report to a router connected to DDC controller for averaging or high and low selection.
- H. One-to-One Wireless Network Receivers:
1. One-to-one wireless receivers receive wireless RF signals containing temperature data from multiple wireless room temperature sensors and communicate information to programmable application controllers or application-specific controllers.
 - a. Use direct-sequence spread spectrum RF technology.
 - b. Operate on 2.4 GHz ISM Band.
 - c. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
 - d. FCC compliant to 47 CFR 15, Subpart B, Class A.
 - e. Operate as a bidirectional transceiver with sensors to confirm and synchronize data transmission.
 - f. Capable of communication up to a distance of 200 ft. (61 m).
 - g. Include visual indication of the following:
 - 1) Power.
 - 2) Receiver activity.
 - 3) Wireless RF transmission from wireless sensors.
 - 4) No transmission, weak signal, adequate signal, or excellent signal.
- I. One-to-One Wireless Network Sensors:
1. One-to-one wireless sensors sense and report room temperatures to one-to-one receiver.
 - a. Use direct-sequence spread spectrum RF technology.
 - b. Operate on 2.4 GHz ISM Band.

- c. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
- d. FCC compliant to 47 CFR 15, Subpart B, Class A.
- e. Include set-point adjustment between 55 to 85 deg F (13 to 30 deg C).

2.12 DESKTOP WORKSTATIONS

- A. Description: A tower or all-in-one computer designed for normal use at a single, semipermanent location.
- B. Performance Requirements:
 - 1. May dictate equipment exceeding minimum requirements indicated.
 - 2. ENERGY STAR compliant.
- C. Personal Computer:
 - 1. RAM:
 - a. Capacity: 8 GB.
 - b. Speed: 1333 MHz.
 - 2. Hard Drive:
 - a. Media: Solid state.
 - b. Number of Hard Drives: One.
 - 3. Optical Read and Write Drive:
 - a. Include with at least 2 MB of data buffer.
 - b. Type: **<Insert type>**.
 - c. Minimum Data Buffer Capacity: **<Insert number and measurement unit>**.
 - d. Minimum Average Access Time: **<Insert number>** ms.
 - e. Nominal Data Transfer Rates:
 - 1) Reading: **<Insert value>** [MB] [TB]/s.
 - 2) Writing: **<Insert value>** [MB] [TB]/s.
 - f. Average access time of 150 ms or less.
 - g. MTBF of at least 100,000 power-on hours.
 - 4. At least four expansion slots of [32] [64] **<Insert number>** bit.
 - 5. Video Card:
 - a. Resolution: **[1920 by 1200]** **<Insert values>** pixels.
 - b. RAM: **<Insert value>** [MB] [GB] [TB].
 - c. Controller Speed: **<Insert value>** [MHz] [GHz].
 - d. On-Board Memory Speed: **<Insert value>** [MHz] [GHz].
 - e. On-Board Memory Data Width: **<Insert number>** bit.
 - 6. Sound Card:
 - a. At least 128 voice wavetable synthesis.
 - b. Capable of delivering three-dimensional sound effects.
 - c. High-resolution, 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.
 - 7. Network Interface Card: Include card with connection, as applicable.
 - a. 10-100-1000 base TX Ethernet with RJ-45 connector port.
 - b. 100 base FX Ethernet with SC or ST port.

D. Wireless Ethernet, 802.11 ac:

1. Optical Modem: Full duplex link for connection to optical fiber cable provided.
2. I/O Ports:
 - a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
 - b. One serial port.
 - c. One parallel port.
 - d. Two PS/2 ports.
 - e. One RJ-45.
 - f. One stereo line-in and headphone/line-out on back panel.
 - g. One microphone and headphone connector on front panel.
 - h. One IEEE 1394 on front and back panel with PCI-e card.
 - i. One ESATA port on back panel.
3. Battery: Life of at least three years to maintain system clock/calendar and ROM, at a minimum.

E. Keyboard:

1. 101 enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to 72 inches (1800 mm) in front of workstation.

F. Pointing Device:

1. Two- or three-button mouse.
2. Wireless operation within up to 72 inches (1800 mm) in front of workstation.

G. Flat Panel Display Monitor:

1. Display:
 - a. Color display with **<Insert inches (mm)>** diagonal viewable area.
 - b. **[Digital] [or] [analog]** input signal.
 - c. Aspect Ratio: **[16 to 9] <Insert value>**.
 - d. Antiglare display.
 - e. Response Time: **<Insert number>** ms.
 - f. Dynamic Contrast Ratio: **[50000 to 1] <Insert ratio>**.
 - g. Brightness: **[250 cd/sq. m] <Insert value>**.
 - h. Tilt adjustable base.
 - i. ENERGY STAR compliant.
 - j. Resolution: **[1920 by 1080] <Insert value>** pixels at 60 Hz with pixel size of **[0.277] <Insert number>** mm or smaller.
 - k. Number of Displays: **[One] [Two] <Insert number>**.

H. Speakers:

1. Two, with individual controls for volume, bass and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

I. I/O Cabling: Include applicable cabling to connect I/O devices.

2.13 PORTABLE WORKSTATIONS

- A. Description: A self-contained computer designed to allow for normal use in different locations and conditions.
- B. Performance Requirements:
 - 1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
 - 2. ENERGY STAR compliant.
 - 3. Hardware and software to support local downloading to DDC controllers.
 - 4. Data transfer rate to DDC controller is to be at network speed.
- C. Processor:
 - 1. RAM:
 - a. Capacity: 8 GB.
 - b. Speed: 1333 MHz.
 - 2. Hard Drive:
 - a. Number of Hard Drives: One.
- D. I/O Ports:
 - 1. Serial port.
 - 2. Shared port for external keyboard or mouse.
 - 3. Four USB 3.0 ports.
 - 4. Ethernet port.
 - 5. HDMI port.
 - 6. IEEE 1394 port.
- E. Battery:
 - 1. Capable of supporting operation of portable workstation for a minimum of 8 hours.
 - 2. Battery life of at least three years.
 - 3. Battery charge time of less than three hours.
- F. Keyboard:
 - 1. 85-key backlit keyboard.
 - 2. Full upper- and lowercase ASCII keyset.
- G. Integral Pointing Device: Touchpad with two buttons. Gesture enabled.
- H. Display:
 - 1. **<Insert inches (mm)>** diagonal or larger high-definition WLED color display.
 - 2. Antiglare screen.
 - 3. **[1920 by 1080] <Insert value>** pixel resolution.
 - 4. Brightness: 300 nits.
- I. Network Interfaces:
 - 1. Network Interface Card: Include card with connection, as application.
 - a. 10-100-1000 base TX Ethernet with RJ-45 connector port.
 - b. 100 base FX Ethernet with SC or ST port.
 - 2. Wireless:
 - a. Internal with integrated antenna, capable of supporting WiFi standards 802.11 a/b/g/n.

2.14 PORTABLE OPERATOR TERMINALS

- A. Description: Handheld device with integral keypad or touch screen operator interface.
- B. Display: Multiple lines of text display for use in operator interaction with DDC system.
- C. Cable: Flexible [**coiling**] cable, at least 36 inches (900 mm) long, with a plug-in jack for connection to DDC controllers, network ports, or instruments with an integral LAN port. As an alternative to hardwired connection, POTs may be accessible to DDC controllers through a wireless network connection.
- D. Power POTs through network connection.
- E. Connection of POTs to DDC system to not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or preclude central initiated commands and system modification.
- F. POTs to give operator ability to do the following:
 - 1. Display and monitor BI point status.
 - 2. Change BO point set point (on or off, open or closed).
 - 3. Display and monitor analog point values.
 - 4. Change analog control set points.
 - 5. Command a setting of AO point.
 - 6. Display and monitor I/O point in alarm.
 - 7. Add a new or delete an existing I/O point.
 - 8. Enable and disable I/O points, initiators, and programs.
 - 9. Display and change time and date.
 - 10. Display and change time schedules.
 - 11. Display and change run-time counters and run-time limits.
 - 12. Display and change time and event initiation.
 - 13. Display and change control application and DDC parameters.
 - 14. Display and change programmable offset values.
 - 15. Access DDC controller initialization routines and diagnostics.
 - 16. **<Insert requirements>**.

2.15 SERVERS

- A. Description: x86-based permanently installed computer used for client-server computing.
- B. Mounting: [**Rack**] [**Blade**] [**Tower**] [**Tower able to be rack mounted**].
- C. Power: [**Single**] [**Dual**] power supply, minimum [**300**] **<Insert value>** W.
- D. Performance Requirements:
 - 1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
 - 2. ENERGY STAR compliant.
 - 3. Minimum Processor Speed: **<Insert gigahertz>**.
 - 4. RAM:
 - a. Capacity: **<Insert value>** [GB] [TB].
 - b. Speed and Type: **<Insert value>** MGz, **<Insert type>**.
 - c. Expandable Capacity: **<Insert value>** [GB] [TB].
 - 5. Redundant Array of Independent Discs: [**Zero**] [**One**] [**Two**] [**Three**] [**Four**] [**Five**] **<Insert number>** configuration.
 - 6. Drive Bays: Eight at 2.5 inches (65 mm) or eight at 3.5 inches (90 mm).

7. Hard-Drive Storage: **[Two]** **[Three]** **[Four]** drives each with **<Insert value> [GB] [TB]** storage and nominal rotational speed of 7200 rpm.
 8. Network Interface: **[Dual-port gigabit Ethernet]** **[Optical fiber]**.
 9. DVD +RW drive.
 10. Color, flat-screen display with **<Insert inches (mm)>** diagonal viewable area.
 11. Keyboard and mouse.
 12. Next-day on-site warranty for **[two]** **[three]** **<Insert number>**-year period following Substantial Completion.
- E. Servers are to include the following:
1. Full-feature backup server (server and backup minimum requirement).
 2. Software licenses.
 3. Cable installation between server(s) and network.
- F. Web Server:
1. If required to be separate, include web server hardware and software to match, except backup server is not required.
 2. Firewalls between server web and networks.
 3. Password protection for access to server from web server.
 4. Cable installation between the server(s) and building Ethernet network.
- G. Power each server through a **[dedicated]** UPS unit.
- 2.16 PRINTERS
- A. Black and White Laser Printer:
1. 1200 by 1200 dots per inch resolution.
 2. First sheet printed within 10 seconds.
 3. **<Insert number>** page per minute rated print speed at best quality mode.
 4. Print buffer with at least **<Insert value>** MB of RAM, expandable to at least 288 MBs.
 5. Complies with ENERGY STAR requirements.
 6. Capable of handling letter- and legal-size paper and overhead transparencies.
 7. Two paper trays; one tray with **<Insert number>** sheet capacity, and one tray with **<Insert number>** sheet capacity.
 8. At least **<Insert number>** page toner/cartridge capacity.
- B. Color Laser Printer:
1. 1200 by 1200 dots per inch resolution black and white, 1200 by 1200 dots per inch resolution black and white and color.
 2. First sheet printed within 10 seconds.
 3. **<Insert number>** page per minute rated print speed at best quality mode.
 4. Print buffer with at least 512 MB of RAM, expandable to at least one GB.
 5. Complies with ENERGY STAR requirements.
 6. Capable of handling letter- and legal-size paper and overhead transparencies.
 7. Two paper trays; one tray with **<Insert number>** sheet capacity, and one tray with 500 **<Insert number>** sheet capacity.
 8. Two-sided printing.
 9. At least **<Insert number>** page toner/cartridge capacity.
- C. Color Inkjet Printer:
1. Inkjet technology with true four-color printing (black, cyan, magenta, and yellow).
 2. Print quality of 1200 by 600 dots per inch with black on inkjet paper and 4800 by 1200 dots per inch color printing on premium photo paper.

3. Rated speed of <Insert number> pages per minute printing black and white in normal mode and <Insert number> pages per minute printing color in normal mode.
4. Two paper trays; one tray with <Insert number> sheet capacity, and one tray with <Insert number> sheet capacity.
5. Capable of handling letter- and legal-size paper and overhead transparencies.
6. <Insert value> MB of RAM.
7. Duplex printing (printing on both sides of paper).

2.17 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser [32-] [or] [64-]bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system capable of operating DOS and Microsoft Windows applications.
3. Database management software to manage all data on an integrated and non-redundant basis. Additions and deletions to database are to be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software to manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software to include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software to schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language pronouncing and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Make operator sign-off a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Make automatic sign-off period programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Record operator sign-on and sign-off activity and send to printer.
6. Security Access:
 - a. Use password control for operator access to DDC system.
 - b. Assign an alphanumeric password (field assignable) to each operator.
 - c. Grant operators access to DDC system by entry of proper password.
 - d. Use same operator password regardless of which computer or other operator interface means are used.
 - e. Automatically update additions or changes made to passwords.
 - f. Assign each operator an access level to restrict access to data and functions the operator is capable of performing.
 - g. Provide software with at least five access levels.
 - h. Assign each menu item an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.

- i. Display menu items to operator with those capable of access highlighted. Make menu and operator access level assignments online programmable and under password control.
7. Data Segregation:
- a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
 - b. Include at least 32 segregation groups.
 - c. Make segregation groups selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.
 - d. Make points assignable to multiple segregation groups. Display and output of data to printer or monitor is to occur where there is a match of operator or peripheral segregation group assignment and point segregations.
 - e. Make alarms displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
 - f. Assign operators and peripherals to multiple segregation groups and make all assignments online programmable and under password control.
8. Operators able to perform commands including, but not limited to, the following:
- a. Start or stop selected equipment.
 - b. Adjust set points.
 - c. Add, modify, and delete time programming.
 - d. Enable and disable process execution.
 - e. Lock and unlock alarm reporting for each point.
 - f. Enable and disable totalization for each point.
 - g. Enable and disable trending for each point.
 - h. Override control loop set points.
 - i. Enter temporary override schedules.
 - j. Define holiday schedules.
 - k. Change time and date.
 - l. Enter and modify analog alarm limits.
 - m. Enter and modify analog warning limits.
 - n. View limits.
 - o. Enable and disable demand limiting.
 - p. Enable and disable duty cycle.
 - q. Display logic programming for each control sequence.
 - r. **<Insert requirements>**.
9. Reporting:
- a. Generated automatically and manually.
 - b. Sent to displays, printers and disc files.
 - c. Types of Reporting:
 - 1) General listing of points.
 - 2) List points currently in alarm.
 - 3) List of off-line points.
 - 4) List points currently in override status.
 - 5) List of disabled points.
 - 6) List points currently locked out.
 - 7) List of items defined in a "Follow-Up" file.
 - 8) List weekly schedules.
 - 9) List holiday programming.
 - 10) List of limits and deadbands.

11) <Insert types>.

10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface is to use a pointing device with pull-down or penetrating menus, color, and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Make descriptors for graphics, points, alarms, and such modifiable through operator's workstation under password control.
5. Make graphic displays online user definable and modifiable using the hardware and software provided.
6. Make data displayed within a graphic assignable regardless of physical hardware address, communication, or point type.
7. Make graphics online programmable and under password control.
8. Make points assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics to also contain software points.
10. Penetration within a graphic hierarchy is to display each graphic name as graphics are selected to facilitate operator understanding.
11. Provide a back-trace feature to permit operator to move upward in the hierarchy using a pointing device. Back trace to show all previous penetration levels. Include operator with option of showing each graphic full-screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Provide operator with ability to select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Display defined and linked graphic below that selection.
14. Include operator with means to directly access graphics without going through penetration path.
15. Make dynamic data assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Make colors variable for each class of points, as chosen by operator.
18. Provide dynamic points with operator adjustable update rates on a per point basis from [one] <Insert value> second to over a [minute] <Insert value>.
19. For operators with appropriate privilege, command points directly from display using pointing device.
 - a. For an analog command point such as set point, display current conditions and limits so operator can position new set point using pointing device.
 - b. For a digital command point such as valve position, show valve in current state such as open or closed so operator could select alternative position using pointing device.
 - c. Include a keyboard equivalent for those operators with that preference.

20. Give operator ability to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot, and other information on other quadrants on screen. This feature allows real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
 21. Help Features:
 - a. Online context-sensitive help utility to facilitate operator training and understanding.
 - b. Bridge to further explanation of selected keywords and contain text and graphics to clarify system operation.
 - 1) If help feature does not have ability to bridge on keywords for more information, provide a complete set of user manuals in an indexed word-processing program, which runs concurrently with operating system software.
 - c. Available for Every Menu Item:
 - 1) Index items for each system menu item.
 22. Provide graphic generation software to allow operator ability to add, modify, or delete system graphic displays.
 - a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols[**similar to those indicated**].
 - b. Use a pointing device in conjunction with a drawing program to allow operator to perform the following:
 - 1) Define background screens.
 - 2) Define connecting lines and curves.
 - 3) Locate, orient, and size descriptive text.
 - 4) Define and display colors for all elements.
 - 5) Establish correlation between symbols or text and associated system points or other displays.
- D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
 2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
 - a. Room layouts with room identification and name.
 - b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
 - c. Location and identification of each hardware point being controlled or monitored by DDC system.
 - d. **<Insert requirements>**.
 3. Control schematic for each of following, including a graphic system schematic representation[, **similar to that indicated on Drawings,**] with point identification, set point and dynamic value indication[, **sequence of operation**] **[and] [control logic diagram]**.
 4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
 5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, **[gateways] [operator workstations] [and] [other network devices]**.

E. Customizing Software:

1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. At a minimum, include the following modification capability:
 - a. Operator Assignment: Designation of operator passwords, access levels, point segregation, and auto sign-off.
 - b. Peripheral Assignment: Assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points, and enabling and disabling of printout of operator changes.
 - c. System Configuration and Diagnostics: Communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points, and application programs and initiation of diagnostics.
 - d. System Text Addition and Change: English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time, and trouble condition.
 - e. Time and Schedule Change: Time and date set, time and occupancy schedules, exception and holiday schedules, and daylight-savings time schedules.
 - f. Point related change capability is to include the following:
 - 1) System and point enable and disable.
 - 2) Run-time enable and disable.
 - 3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
 - 4) Assignment of alarm and warning limits.
 - g. Application program change capability is to include the following:
 - 1) Enable and disable of software programs.
 - 2) Programming changes.
 - 3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.
4. Provide software to allow operator ability to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Make additions and modifications online programmable using operator workstations, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, upload and record database on hard drive and disc for archived record.
5. Include high-level language programming software capability for implementation of custom DDC programs. Include a compiler, linker, and up- and down-load capability.
6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic, and relational operators for implementation of control sequences. Also include, at a minimum, the following:
 - a. Proportional control (P).
 - b. Proportional plus integral (PI).
 - c. Proportional plus integral plus derivative (PID).

- d. Adaptive and intelligent self-learning control.
 - 1) Algorithm monitors loop response to output corrections and adjust loop response characteristics in accordance with time constant changes imposed.
 - 2) Algorithm operates in a continuous self-learning manner and retains in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
 - 7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
 - 8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
 - 9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
 - 10. Relational operators such as "Equal to," "Not Equal to," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.
- F. Alarm Handling Software:
- 1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers[, **gateways**] **[and other network devices]**.
 - 2. Include first in, first out handling of alarms in accordance with alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
 - 3. Make alarm handling active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
 - 4. Alarms display is to include the following:
 - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
 - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
 - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
 - d. Include extended message capability to allow assignment and printing of extended action messages. Capability is to be operator programmable and assignable on a per point basis.
 - 5. Direct alarms to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
 - 6. Send email alarm messages to designated operators.
 - 7. Send email, page, text, and voice messages to designated operators for critical alarms.
 - 8. Categorize and process alarms by class.
 - a. Class 1:
 - 1) Associated with fire, security, and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
 - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
 - 3) All conditions make an audible alarm sound and require individual acknowledgment to silence audible sound.
 - b. Class 2:
 - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
 - 2) Acknowledgement may be through a multiple alarm acknowledgment.

- c. Class 3:
 - 1) General alarms; printed, displayed, and placed in unacknowledged alarm buffer queues.
 - 2) Configure so each new alarm received makes an audible alarm sound that are silenced by "acknowledging" alarm or by pressing a "silence" key.
 - 3) Make acknowledgement of queued alarms either on an individual basis or through a multiple alarm acknowledgement.
 - 4) Print alarms returning to normal condition without an audible alarm sound or require acknowledgment.
- d. Class 4:
 - 1) Routine maintenance or other types of warning alarms.
 - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
- 9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
- 10. To ensure that no alarm records are lost, make it possible to assign a backup printer to accept alarms in case of failure of primary printer.
- G. Reports and Logs:
 - 1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
 - 2. Setup each report so data content, format, interval, and date are operator definable.
 - 3. Sample and store report data on DDC controller, within storage limits of DDC controller, and then uploaded to archive on **[workstation]** **[server]** for historical reporting.
 - 4. Make it possible for operators to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
 - 5. Store reports and logs on **[workstations]** **[and]** **[servers]** hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
 - 6. Make reports and logs readily printable and set to be print either on operator command or at a specific time each day.
- H. Standard Reports: Provide standard DDC system reports with operator ability to customize reports later.
 - 1. All I/O: With current status and values.
 - 2. Alarm: All current alarms, except those in alarm lockout.
 - 3. Disabled I/O: All I/O points that are disabled.
 - 4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
 - 5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
 - 6. Logs:
 - a. Alarm history.
 - b. System messages.
 - c. System events.
 - d. Trends.
 - e. **<Insert requirement>**.
- I. Custom Reports: Operator able to easily define and prepare any system data into a daily, weekly, monthly, annual, or other historical report. Reports to include a title with time and date stamp.

- J. Tenant Override Reports: Prepare Project-specific reports.
 - 1. Daily report showing total time in hours that each tenant has requested after-hours HVAC.
 - 2. Weekly report showing daily total time in hours that each tenant has requested after-hours HVAC.
 - 3. Monthly report showing daily total time in hours that each tenant has requested after-hours HVAC.
 - 4. Annual summary report that shows after-hours HVAC usage on a monthly basis.
- K. HVAC Equipment Reports: Prepare Project-specific reports.
 - 1. Chiller Report: Daily report showing operating conditions of each chiller in accordance with ASHRAE 147 including, but not limited to, the following:
 - a. Chilled-water entering temperature.
 - b. Chilled-water leaving temperature.
 - c. Chilled-water flow rate.
 - d. Chilled-water inlet and outlet pressures.
 - e. Evaporator refrigerant pressure and temperature.
 - f. Condenser refrigerant pressure and liquid temperature.
 - g. Condenser-water entering temperature.
 - h. Condenser-water leaving temperature.
 - i. Condenser-water flow rate.
 - j. Refrigerant levels.
 - k. Oil pressure and temperature.
 - l. Oil level.
 - m. Compressor refrigerant discharge temperature.
 - n. Compressor refrigerant suction temperature.
 - o. Addition of refrigerant.
 - p. Addition of oil.
 - q. Vibration levels or observation that vibration is not excessive.
 - r. Motor amperes per phase.
 - s. Motor volts per phase.
 - t. Refrigerant monitor level (PPM).
 - u. Purge exhaust time or discharge count.
 - v. Ambient temperature (dry bulb and wet bulb).
 - w. Date and time logged.
 - x. **<Insert requirement>.**
 - 2. **<Insert requirements for each type of HVAC equipment requiring a report>.**
- L. Utility Reports: Prepare Project-specific reports.
 - 1. Electric Report:
 - a. Include weekly report showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - b. Include monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - c. Include annual report showing monthly electrical consumption and peak electrical demand with time and date stamp for each meter.
 - d. For each weekly, monthly, and annual report, include sum total of submeters combined by load type, such as lighting, receptacles, and HVAC equipment showing daily electrical consumption and peak electrical demand.
 - e. For each weekly, monthly, and annual report, include sum total of all submeters in building showing electrical consumption and peak electrical demand.

2. Natural Gas Report:
 - a. Include weekly, monthly, and annual report showing daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
 - b. For each weekly, monthly, and annual report, include sum total of submeters combined by load type, such as boilers and service water heaters showing daily natural gas consumption and peak natural gas demand.
 - c. For each weekly, monthly, and annual report, include sum total of all submeters in building showing natural gas consumption and peak natural gas demand.
 3. Service Water Report:
 - a. Include weekly, monthly, and annual report showing daily service water consumption and peak service water demand with time and date stamp for each meter.
 - b. For each weekly, monthly, and annual report, include sum total of submeters combined by load type, such as cooling tower makeup and irrigation showing daily service water consumption and peak service water demand.
 - c. For each weekly, monthly, and annual report, include sum total of all submeters in building showing service water consumption and peak service water demand.
 4. **<Insert requirements for each utility requiring a report>.**
- M. Energy Reports: Prepare Project-specific daily, weekly, monthly, **[and annual]** [, **annual and since-installed**] energy reports.
1. Prepare report for each purchased energy utility, indicating the following:
 - a. Time being reported with beginning and end date, and time indicated.
 - b. Consumption in units of measure commonly used to report specific utility consumption over time.
 - c. Gross area served by utility.
 - d. Consumption per unit area served using utility-specific unit of measure.
 - e. Cost per utility unit.
 - f. Utility cost per unit area.
 - g. Convert all utilities to a common energy consumption unit of measure and report for each utility.
 - h. Consumption per unit area using common unit of measure.
 2. Prepare report for each renewable energy source, indicating the following:
 - a. Time being reported with beginning and end date, and time indicated.
 - b. Harvested energy in units of measure commonly used to report specific harvested energy consumption over time.
 - c. Gross area served by renewable energy source.
 - d. Harvested energy per unit area served using specific unit of measure.
 - e. Cost per purchased utility unit displaced by renewable energy.
 - f. Cost savings attributed to harvested energy source.
 - g. Cost savings per unit area attributed to harvested energy.
 - h. Convert all renewable energy sources to a common energy consumption unit of measure and report for each.
 - i. Harvested energy per unit area using common unit of measure.
 3. Prepare purchased energy utility report for each submetered area that indicates the following:
 - a. Time being reported with beginning and end date, and time indicated.
 - b. Gross area served.
 - c. Energy consumption by energy utility type.

- d. Energy consumption per unit area by energy utility type.
 - e. Total energy consumption of all utilities in common units of measure.
 - f. Total energy consumption of all utilities in common units of measure per unit area.
 - g. Unit energy cost by energy utility type.
 - h. Energy cost by energy utility type.
 - i. Energy cost per unit area by energy utility type.
 - j. Total cost of all energy utilities.
 - k. Total cost of all energy utilities per unit area.
4. Prepare Project total purchased energy utility report that combines all purchased energy utilities and all areas served. Project total energy report is to indicate the following:
- a. Time being reported with beginning and end date, and time indicated.
 - b. Gross area served.
 - c. Energy consumption by energy utility type.
 - d. Energy consumption per unit area by energy utility type.
 - e. Total energy consumption of all utilities in common units of measure.
 - f. Total energy consumption of all utilities in common units of measure per unit area.
 - g. Unit energy cost by energy utility type.
 - h. Energy cost by energy utility type.
 - i. Energy cost per unit area by energy utility type.
 - j. Total cost of all energy utilities.
 - k. Total cost of all energy utilities per unit area.
- N. HVAC System Efficiency Reports: Prepare Project-specific **[daily] [weekly] [monthly] [and annual]** [, **annual and since-installed**] HVAC system efficiency reports.
1. Prepare report for **[each]** chilled-water system, indicating the following:
- a. Time being reported with beginning and end date, and time indicated.
 - b. Cooling energy supplied during period.
 - c. Power energy consumed during period by cooling equipment used to produce cooling energy supplied. **[List power consumed for each individual piece of equipment in system and summed total of all equipment in system.]**
 - d. Energy efficiency coefficient of performance determined by dividing power energy consumed into cooling energy supplied.
 - e. Energy efficiency determined by dividing cooling energy supplied into power energy consumed.
 - f. Units of measure used in report to be consistent with units indicated for system.
2. Prepare report for **[each]** heating hot-water system, indicating the following:
- a. Time being reported with beginning and end date, and time indicated.
 - b. Heating energy supplied during period.
 - c. Fuel consumed during period by boilers used to produce heating energy supplied. **[List fuel consumed for each individual piece of equipment in system and summed total of all equipment in system.]**
 - d. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
 - e. Units of measure used in report are to be consistent with units indicated for system.
3. Prepare report for **[each]** steam system, indicating the following:
- a. Time being reported with beginning and end date, and time indicated.
 - b. Heating energy supplied during period.

- c. Fuel consumed during period by boilers used to produce heating energy supplied. [**List fuel consumed for each individual piece of equipment in system and summed total of all equipment in system.**]
 - d. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
 - e. Units of measure used in report are to be consistent with units indicated for system.
4. **<Insert requirements for each HVAC system requiring a report>.**
- O. Weather Reports:
- 1. Include daily report showing the following:
 - a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
 - b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
 - c. Daily minimum, maximum, and average outdoor dew point temperature.
 - d. Number of heating degree-days for each day calculated from a base temperature of **[55 deg F (13 deg C)] <Insert temperature>.**
 - e. Number of cooling degree-days for each day calculated from a base temperature of **[65 deg F (18 deg C)] <Insert temperature>.**
 - f. Daily minimum, maximum, and average outdoor carbon dioxide level.
 - g. Daily minimum, maximum, and average relative humidity.
 - h. Daily minimum, maximum, and average barometric pressure.
 - i. Daily minimum, maximum, and average wind speed and direction.
 - 2. Include weekly report showing the following:
 - a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
 - b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
 - c. Daily minimum, maximum, and average outdoor dew point temperature.
 - d. Number of heating degree-days for each day calculated from a base temperature of **[55 deg F (13 deg C)] <Insert temperature>.**
 - e. Number of cooling degree-days for each day calculated from a base temperature of **[65 deg F (18 deg C)] <Insert temperature>.**
 - f. Weekly minimum, maximum, and average outdoor carbon dioxide level.
 - g. Daily minimum, maximum, and average relative humidity.
 - h. Daily minimum, maximum, and average barometric pressure.
 - i. Daily minimum, maximum, and average wind speed and direction.
 - 3. Include monthly report showing the following:
 - a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
 - b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
 - c. Daily minimum, maximum, and average outdoor dew point temperature.
 - d. Number of heating degree-days for each day calculated from a base temperature of **[55 deg F (13 deg C)] <Insert temperature>.**
 - e. Number of cooling degree-days for each day calculated from a base temperature of **[65 deg F (18 deg C)] <Insert temperature>.**
 - f. Monthly minimum, maximum, and average outdoor carbon dioxide level.
 - g. Daily minimum, maximum, and average relative humidity.
 - h. Daily minimum, maximum, and average barometric pressure.
 - i. Daily minimum, maximum, and average wind speed and direction.
 - 4. Include annual (12-month) report showing the following:
 - a. Monthly minimum, maximum, and average outdoor dry-bulb temperature.
 - b. Monthly minimum, maximum, and average outdoor wet-bulb temperature.
 - c. Monthly minimum, maximum, and average outdoor dew point temperature.

- d. Number of heating degree-days for each month calculated from a base temperature of **[55 deg F (13 deg C)]** <Insert temperature>.
- e. Number of cooling degree-days for each month calculated from a base temperature of **[65 deg F (18 deg C)]** <Insert temperature>.
- f. Annual minimum, maximum, and average outdoor carbon dioxide level.
- g. Monthly minimum, maximum, and average relative humidity.
- h. Daily minimum, maximum, and average barometric pressure.
- i. Daily minimum, maximum, and average wind speed and direction.

P. Standard Trends:

1. Trend all I/O point present values, set points, and other parameters indicated for trending.
2. Associate trends into groups, and setup a trend report for each group.
3. Store trends within DDC controller and uploaded to hard drives automatically on reaching **[75]** <Insert number> percent of DDC controller buffer limit, or by operator request, or by archiving time schedule.
4. Preset trend intervals for each I/O point after review with Owner.
5. Make trend intervals operator selectable from 10 seconds up to 60 minutes. Make minimum number of consecutive trend values stored at one time 100 per variable.
6. When drive storage memory is full, overwrite oldest data with most recent data.
7. Make archived and real-time trend data available for viewing numerically and graphically by operators.

Q. Custom Trends: Operator-definable custom trend log for any I/O point in DDC system.

1. Include each trend with interval, start time, and stop time.
2. Sample and store data on DDC controller, within reaching **[75]** <Insert number> percent storage limits of DDC controller, and then uploaded to archive on **[workstation]** **[server]** hard drives.
3. Make data retrievable for use in spreadsheets and standard database programs.

R. Programming Software:

1. Include programming software to execute sequences of operation indicated.
2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
3. Programming Software: **[As follows]** **[Any of the following]** **[One of the following]**:
 - a. Graphic Based: Use a library of function blocks made from preprogrammed code designed for DDC control systems.
 - 1) Assemble function blocks with interconnection lines that represent to control sequence in a flowchart.
 - 2) Make programming tools viewable in real time to show present values and logical results of each function block.
 - b. Menu Based: Done by entering parameters, definitions, conditions, requirements, and constraints.
 - c. Line by Line and Text Based: Programming is to declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.
4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

S. Database Management Software:

1. Where a separate SQL database is used for information storage, include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
2. Secure database access using standard SQL authentication including ability to access data for use outside of DDC system applications.
3. Include database management function summarizing information on trend, alarm, event, and audit for the following database management actions:
 - a. Backup.
 - b. Purge.
 - c. Restore.
4. Database management software supporting the following:
 - a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
 - b. Maintenance: Include method of purging records from trend, alarm, event, and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
 - c. Backup: Include means to create a database backup file and select a storage location.
 - d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.
5. Information of current database activity, including the following:
 - a. Ready.
 - b. Purging record from a database.
 - c. Action failed.
 - d. Refreshing statistics.
 - e. Restoring database.
 - f. Shrinking a database.
 - g. Backing up a database.
 - h. Resetting Internet information services.
 - i. Starting network device manager.
 - j. Shutting down the network device manager.
 - k. Action successful.
6. Database management software monitoring functions is to continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and email message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window with the following Sections:
 - a. Allow operator to set and review scan intervals and start times.
 - b. Email: Allow operator to create and review email and phone text messages to be delivered when a warning or an alarm is generated.
 - c. Warning: Allow operator to define warning limit parameters, set reminder frequency, and link email message.
 - d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency, and link email message.
 - e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event, and audit databases as well as operator proper security access to restore a database.

9. Monitoring settings taskbar with following informational icons:
 - a. Normal: Indicates by color and size, or other easily identifiable means, that all databases are within their limits.
 - b. Warning: Indicates by color and size, or other easily identifiable means, that one or more databases have exceeded their warning limit.
 - c. Alarm: Indicates by color and size, or other easily identifiable means, that one or more databases have exceeded their alarm limit.

2.18 ANALYTICS SOFTWARE

- A. Scope: Incorporate analytics software into DDC System:
 1. Licensing, without Recurring Cost: No re-occurring cost for licensing and subscriptions.
 2. Licensing: With or without re-occurring cost for licensing and subscriptions.
 - a. For products with re-occurring costs, provide incremental costs broken down over a **[five] [10] <Insert value>**-year operating period that begins at Substantial Completion.
 - b. Setup service agreements direct to Owner.
 3. Purpose: Analyze energy and operational data to identify faults and opportunities for improved performance and reduced energy use.
 4. Verification: Verify that HVAC systems and associated sequence of operations are executing as specified or as described on Drawings, through the analysis of energy and operational data, identification of faults showing where control sequences are not functioning as prescribed, and identification of opportunities for improved performance in the operation of systems.
- B. Use during Project Life:
 1. During Construction: Use for verification of performance during startup, commissioning, and final acceptance of DDC system.
 2. During Warranty Period: Use for continuous operational tuning of DDC system and verification of operation and designed to identify warranty issues preemptively, thus reducing failures and potential down time.
 3. After Warranty Period: Use to diagnose ongoing operational degradation and for Owner to perform continuous monitoring-based commissioning.
- C. Minimum Features and Capabilities:
 1. Operating Systems: Current version of Windows-based operating systems.
 2. Time Series Database: Database technology, designed for efficient storage and analysis of large volumes of time series data, using tagging to model and describe data; supports an open-source tagging standard.
 3. Data Import: Ability to accept and normalize data from a variety of sources including SQL compatible databases, CSV format files, XML format files or web services, and other EDI techniques. Once imported, software is to provide a unified data format to enable analytics algorithms to identify patterns across different data sets.
 4. Open Interfaces: Open, REST-based APIs to enable integration with third-party software applications. Open APIs are to enable data to be entered/imported into database, exported from database, posting of analytic queries, and output of analytic results. APIs are to be fully documented and available as part of standard product.
 5. Host: Local deployed on DDC system network.
 6. Weather Data Service: Built-in worldwide weather service providing weather data including, but not limited to, the following:
 - a. Current temperature.
 - b. High temperature for the day.

- c. Low temperature for the day.
 - d. Sunrise and sunset times.
 - e. Relative humidity.
 - f. Degree days (heating and cooling with adjustable balance point value).
 - g. Seven-day forecast.
 - h. Historical weather data extending back at least one year.
- 7. Email Notification: Automatic notification of detected issues via email including, but not limited to, the following:
 - a. Immediate notification of detected issues.
 - b. Daily digest or summary of detected issues.
 - c. Ability to delineate which notifications are sent to which recipients down to the level of specifying individual issues sent to individual recipients.
- D. Hardware Requirements:
 - 1. Host on a server in a virtual environment complying with Owner's security requirements.
 - 2. Comply with standard software and hardware profiles required by Owner.
- E. Analytic Rules:
 - 1. Custom Rule Development: Develop customized rules and algorithms tailored to operational needs and characteristics of individual facilities and needs of monitoring and verification project and fault-detection requirements of Project without depending on manufacturer for rule development. Provide tools for user development and full documentation.
 - 2. Standard Analytic Functions: Library of standard analytic functions is to use these standard analytic functions as elements to build custom analytic rules for specific needs of individual facilities.
 - 3. Existing library of not less than 200 standard analytic rules written for applications similar to those required for this Project.
- F. Reporting:
 - 1. Standard Views of Analytic Results: Standard views to present analytic results, automatically generated when issues are found by analytic rules including, but not limited to, the following:
 - a. Rules violations across a portfolio of sites, rules violations per site, including time, date, and duration of all violations.
 - b. Ability to assign cost relationships to rule logic to provide cost per violation.
 - c. Standard filters to enable operator to easily look at rule violations by site, data, and violation type for any selected date or date range.
 - d. Automatic calculation and presentation of Key Performance Indicators (KPIs) and to define custom KPIs as needed.
 - 2. Custom Views of Analytic Results:
 - a. Any standard system view is to be able to be saved as a custom report including its configuration criteria, e.g., time range, sites, rule violations, or other configuration options as applicable to standard system view.
 - b. Created by making queries against the database and saving the query as a saved report executed by single mouse click.
 - c. Export: Support report views export into CSV, Excel, XML, and HTML format, accomplished in a couple of mouse clicks.

G. Energy-Specific Reporting and Information Presentation Tools:

1. Greenhouse Gas Analysis: Energy/carbon dioxide relationships; easily changed and added without involvement of software manufacturer.
2. Energy Baseline: Quantify and define energy consumption and demand baselines (including weather normalization metrics) and compare actual and forecasted energy demand and consumption against those baselines.
3. Benchmarking: Multisite benchmarking to compare energy consumption and demand profiles and baselines across all buildings within Owner's portfolio.
4. Forecasting: Forecast near-future loads by using historic trends and forecasted weather data.
5. Financial Analysis: Calculate costs based on energy consumption and demand and energy costs and associate costs with any faults discovered by any analytic function and perform model- or tariff-based calculations to determine costs.
6. Tracking of Key Performance Indicators: Definition and tracking of user-defined key performance indicators/operational metrics. Examples include energy demand and consumption normalized for area and weather, peak demand, and consumption shown with minimum and maximum ranges across any user-selectable period.
7. Correlation of Energy Use with Equipment Operation: Automatically present views showing correlation between energy demand and consumption and operation of loads associated with that usage. Include the following:
 - a. All submeters and virtual meters.
 - b. Weather data as a selectable item.

H. Implementation:

1. Apply analytic rules to all HVAC systems and equipment monitored and controlled by DDC system. To extent available, use a subset of rules in existing rules library.
2. Implement rules to aid in determining proper operation of any HVAC system with a programmed sequence of operation.
3. Generate reports to aid in verification of proper operation during initial system startup and commissioning to supplement (not replace) commissioning agent reports.
4. Prepare quarterly reports summarizing faults detected and KPIs, including recommended corrective action.

I. Training:

1. Train Owner sufficiently to use software without need for external support.

2.19 MAINTENANCE MANAGEMENT SOFTWARE

A. Scope:

1. Include complete and functional software-driven maintenance management system to perform scheduling of preventive maintenance and generation of work orders, for mechanical and electrical equipment and systems, and other equipment and systems indicated.
2. Automatically generate work orders from alarm conditions, run time, and calendar time. For each work order generated, list parts, tools, and craftspeople and define task to be performed.
3. Use work orders generated to schedule a repair or preventive maintenance routine.
4. Use work orders to track completion of work, parts used, and total cost of repair.
5. Include a database inventory tracking system to automatically update inventory database to show quantity of tools, repair parts, and expendables used for a work order.
6. Print work orders and preventive maintenance schedules[**on a printer assigned solely to maintenance management function**].

B. Additional Hardware Requirements:

1. Maintenance management software is to not require additional hardware[, **except for an additional printer that is dedicated to maintenance management**].

C. Integration: Integrate maintenance management software into DDC system.

D. Software Requirements:

1. From main menu of maintenance management system, use selection of icons to penetrate to individual functions described below.
2. Work Orders:
 - a. Automatically generate work orders initiated from alarm conditions, accumulated run time, or calendar time. Work orders generated are to specify a particular task to be accomplished including labor, material, and tools needed to accomplish work.
 - b. Include at least two of the following types of work orders:
 - 1) Corrective and Emergency Maintenance: Generate for a specific job or repair for emergency, breakdown, or scheduled work.
 - 2) Preventive Maintenance: Use on a periodic basis to generate preventive maintenance work orders.
 - c. Include the following functions:
 - 1) Work Order Tracking: Perform every function related to processing work orders including creating, approving and initiating work orders, checking their status history, and closing or reworking them when appropriate.
 - 2) Work Requests: Report any problems that require corrective maintenance activity generated by dispatchers and those people designated to request work orders.
 - 3) Quick Reporting: Report work done on an open work order or a small job.
 - 4) Work Manager: Specify type of labor to be applied to a specific work order at specific times. Include capability to dispatch one or more laborers to top-priority jobs on as-needed basis and to interrupt work in progress to reassign labor to higher priority tasks.
 - d. Reports:
 - 1) Daily Maintenance Schedule by Supervisor: List a schedule of open work orders for a specified date by supervisor.
 - 2) Equipment Cost Roll-up Report: Include a roll-up of equipment costs incurred since the date the report was last run.
 - 3) Delinquent Work Order Report: List open work orders whose target completion date is earlier than the date the report is run.
 - 4) Employee Job Assignments: List labor codes that have job assignments for specified date.
 - 5) Daily Work Order Assignment: List work orders that have labor assignments for specified date.
 - 6) Estimated versus Actual Work Order Costs: List a cost summary of outstanding work orders.
 - 7) Open Work Orders Report: List open work orders for locations and equipment.
3. Inventory:
 - a. Include an inventory tracking system to keep track of stocked, non-stocked, and special-order items.

- b. Link inventory tracking to database and when items are consumed, as noted on a work order issued by system, and automatically update inventory of stocked items.
- c. Include the following functions:
 - 1) Inventory Control: Enter, display, and update information on each inventory item. Allow viewing of master inventory records that are independent of storeroom locations or item/location records. Include a screen that lists inventory transactions that move items in or out of inventory or from one storeroom location to another. Minimum information tracked is to include the following:
 - a) Vendors supply items.
 - b) Item balances, including the bin and lot level for each storeroom location.
 - c) Alternative items.
 - 2) Issues and Transfers: Issue stock directly from inventory, with or without a work order. When transfer of stock from one location to another location occurs, provide appropriate adjustments in stock balance record. Include a trace record of stock transfers from one storeroom to another.
 - 3) Item Assembly Structures: Include modeling of equipment with inventory items and building of equipment and location hierarchies.
 - 4) Metered Material Usage:
 - a) Track usage by a piece of equipment.
 - b) Record against a standing work order for a selected piece of equipment.
 - c) Include a material usage transaction for each item of material used and provide as an input to calculation for per unit material consumption report for a piece of equipment.
- d. Reports:
 - 1) Inventory Analysis Report: List for a given storeroom location, inventory items analysis information that allows quick identification of which inventory items represent greatest monetary investment for dollar value and rate of turnover.
 - 2) Inventory Cycle Count Report: List for a specified storeroom, inventory items that are due to be cycle-counted, based on cycle-count frequency and last count date.
 - 3) Economic Order Quantity Report: For a given storeroom location, display optimum economic ordering quantity for items in selected results set.
 - 4) Inventory Pick Report: A pick list, by work order for items needed to be pulled from a designated storeroom's inventory for work orders having a target start date of specified date.
 - 5) Suggested Order Report: List inventory items in selected results set that are due to be recorded, for a specified storeroom location, based on the following calculation: Suggest a reorder if current balance minus reserve quantity plus on-order quantity is less than reorder point.
 - 6) Reorder Point Report: List selected set of items and optimum minimum level to have in stock based on demand, lead delivery time, and a reserve safety stock.
 - 7) Inventory Valuation Report: Gives an accounting of cost of current inventory, for inventory records in a designated storeroom location.
 - 8) Item Order Status: Lists items on order.

- 9) List of Expired Items: Lists expired lot items in a storeroom. Report is to include item number, description, expiration date, bin number, lot number, manufacturer lot number, and quantity of expired items in that lot and bin.
- 10) Item Availability at All Locations: Lists alternative storeroom locations for selected items.
- 11) Where Used Report: List equipment on which item is recorded as being used.

4. Equipment:

- a. Include equipment and location records; establish relationships between equipment, between locations, and between equipment and locations; track maintenance costs; and enter and review meter readings.
- b. Include the following functions:
 - 1) Equipment: Store equipment numbers and corresponding information including equipment class, location, vendor, up/down status, and maintenance costs for each piece of equipment. Include building of equipment assemblies. Provide equipment assemblies hierarchical ordering for arrangement of buildings, departments, equipment, and sub-assemblies.
 - 2) Operating Locations: Facilitate creation of records for operating locations of equipment, and track equipment that is used in multiple locations. In addition, allow hierarchical organization of equipment operating in facility by means of grouping equipment locations into areas of responsibility.
 - 3) Failure Codes: Develop and display failure hierarchies to acquire an accurate history of types of failures that affect equipment and operating locations.
 - 4) Condition Monitoring: Display time-related or limit measurements recorded for a piece of equipment. Generate work orders from this screen and to take immediate action on problem conditions.
- c. Reports:
 - 1) Availability Statistic by Location: List equipment availability by location over a user-specified period.
 - 2) Equipment Failure Summary: List total number of failures by problem code for a piece of equipment for specified period.
 - 3) Detailed Equipment Failure Report by Equipment: List of failure reports for the current piece of equipment for specified period.
 - 4) Equipment Hierarchy Report: List of equipment.
 - 5) Equipment History Graphs: Include a graphical report in histogram format that displays equipment breakdown history over a specified period.
 - 6) Equipment Measurement Report: Tabular listing and description of each measurement point for a piece of equipment and history of measurements taken for that point.
 - 7) Maintenance Cost by Equipment: List of transactions costs for elected equipment in the specified date range.
 - 8) Failure Count by Equipment: Graphically report number of failures for each piece of equipment showing number of failures for each piece of equipment over a specified period, occurrence of each problem code within set of failures, and failures by problem code.
 - 9) Failure Analysis Graphs: Graphically report number of failures for each piece of equipment over a specified period, number of occurrences of each problem code within set of failures, and failures by problem code.
 - 10) Failure Code Hierarchy Report: List of failure codes in each level of failure hierarchy.

- 11) Location Failure Summary: A summary for each selected location of failures reported and any hierarchy level locations for specified period.
 - 12) Failure Summary by Location: A summary of failures for selected location and their subordinate locations that are part of hierarchical system.
 - 13) Detailed Failure Report by Location: List all failures for selected location and its subordinate locations that are part of hierarchical system.
 - 14) Maintenance Cost by System: List of total costs reported in a given date range for locations in selected hierarchical system.
 - 15) Location Hierarchy Report: Lists member locations of hierarchical system displayed in hierarchical fashion.
5. Purchasing:
- a. Include preparation and generation of purchase requisitions and purchase orders; to report receipt of both items and services, match invoices with purchase orders and receipts and define and convert foreign currencies.
 - b. Include the following functions:
 - 1) Purchase Requisition: Create and process purchase requisitions for items and services.
 - 2) Purchase Orders: Create and process purchase orders for items and services from scratch or from purchase requisitions. Record receipts of items and services.
 - 3) Invoices: Include functionality to match purchase orders with invoices and receipts. It is also possible to match a service receipt to an invoice. Project for entering of an invoice for bills that do not require purchase orders or receipts.
 - 4) Currency Management: Define currencies and specify exchange rates. Include preparation of purchase requisitions and purchase orders in currency of vendor while tracking costs in systems base currency.
 - c. Reports:
 - 1) Invoice Approval Report: Include an approval form for entered invoices.
 - 2) Inventory Receipts Register: List purchase orders and inventory received for user-specified time frame.
 - 3) Direct Purchase Back-Order Report: List of items ordered as a direct purchase not received by required delivery date.
 - 4) Standard Purchase Order: A printing of primary purchase order with vendors shipping information, and items purchased.
 - 5) Purchase Order Status Report: List of purchase orders whose status has changed during a certain period.
 - 6) Standard Purchase Requisition: A printing of primary purchase requisition, including vendor name and shipping information.
6. Job Plans:
- a. Include creation of a detailed description of work to be performed by work order. Job plan is to contain operations, procedures and list of estimated material, labor, and tools required for work.
7. Labor:
- a. Store information on employees, contractors, and crafts and include the following functions:
 - 1) Labor: Create, modify, and view employee records. Employee records are to contain pay rate, overtime worked, overtime refused, specials skills, and certifications.

- 2) Crafts: Create, modify, and view craftspeople records.
 - 3) Labor Reporting: Report labor usage by employee or craft externally from work orders module.
 - b. Reports:
 - 1) Employee Attendance Analysis: List of planned attendance, actual attendance, and vacation and sick time in hours as a percentage of planned attendance for selected employees for specified period.
 - 2) Labor Productivity Analysis: List of actual labor hours by labor report category showing each by percentage.
 - 3) Labor Availability versus Commitments by Crafts: A graphical report that details available labor hours versus committed work order hours by craft and day.
8. Calendars:
 - a. Establish calendar records indicating working time for equipment, location, craft, and labor records.
9. Resources:
 - a. Include entry and retrieval of data associated with resources required to maintain facility and to include the following functions:
 - 1) Companies: Establish and update data on vendors and other companies.
 - 2) Tools: Create and maintain information on the tools used on jobs. Make information contained within this module available to job plans and work orders.
 - 3) Service Contracts: Specify information on service contracts with vendors or manufacturers.
10. Custom Applications:
 - a. Include creation of customized database tables and application screens that supplement functions specified.
11. Setup:
 - a. Include configuration of database, security, and setup applications.
 - b. Perform the following functions:
 - 1) Reports and Other Applications: Register reports and other applications for use within system.
 - 2) Documents: Enter, track, and link information from Drawings to equipment and inventory items.
 - 3) Chart of Accounts: Add or modify accounts; set up financial periods; enter inventory accounts, company accounts, and resource recovery accounts; and define tax codes and rates.
 - 4) Signature Security: Establish each user's access rights to modules, applications, screens, and options.
 - 5) Database Configuration: Customize database, including adjusting field lengths and modifying data types.
 - 6) Application Setup: Change position of icons and menu items on the main menu screen.
 - 7) Application Launching: Allow for connecting of third-party applications to data fields and push buttons.

12. Utilities:

- a. Include utilities module that allows system administrator to customize system and to maintain database.
- b. Include the following functions:
 - 1) Interactive SQL: Include access to database for database management functions of import/export and backup.
 - 2) Edit Windows: Display a dialog box to customize an application.
 - 3) Archive Data: Remove records from database and store them for future reference.

E. Documentation:

1. Include complete documentation for system consisting of a User Manual and Systems Administrator Guide.
2. Describe how to use each application module and screen with step-by-step instructions detailing entry and retrieval of data for functions specified.
3. Include a step-by-step description of how each report is defined and retrieved.
4. Bind documentation and clearly title it indicating volume number and use.

2.20 OFFICE APPLICATION SOFTWARE

- A. Include current version of office application software at time of Substantial Completion.
- B. Office application software package to include multiple separate applications and use a common platform for all applications.
 1. Database.
 2. Email.
 3. Presentation.
 4. Publishing.
 5. Spreadsheet.
 6. Word processing.

2.21 ASHRAE 135 GATEWAYS

- A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, **<Insert equipment,>** and variable-speed drives.
- B. Include gateways to connect BACnet to legacy systems where indicated, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment.
- C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.
- D. Gateway Minimum Requirements:
 1. Read and view all readable object properties on non-BACnet network to BACnet network, and vice versa, where applicable.
 2. Write to all writable object properties on non-BACnet network from BACnet network, and vice versa, where applicable.
 3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet, and vice versa.
 4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs in accordance with ASHRAE 135.

5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
6. Backup programming and parameters on CD media with ability to modify, download, backup, and restore gateway configuration.

2.22 ASHRAE 135 PROTOCOL ANALYZER

- A. Analyzer and required cables and fittings for connection to ASHRAE 135 network.
- B. Include the following minimum capabilities:
 1. Capture and store to a file data traffic on all network levels.
 2. Measure bandwidth usage.
 3. Filtering options with ability to ignore select traffic.

2.23 CTA-709.1-D NETWORK HARDWARE

- A. Routers:
 1. Network routers, including routers configured as repeaters, are to comply with requirements of CTA-709.1-D and include connection between two or more CTA-709.3 TP/FT-10 channels or between two or more CTA-709.3 TP/FT-10 channels and a TP/XF-1250 channel.
 2. IP Routers:
 - a. Perform layer three routing of CTA-709.1-D packets over an IP network in accordance with CTA-852-C.
 - b. Include appropriate connection to IP network and connections to CTA-709.3 TP/FT-10 or TP/XF-1250 network.
 - c. Support the Dynamic Host Configuration Protocol for IP configuration and use of an CTA-852-C Configuration Server (for CTA-852-C configuration), but do not rely on these services for configuration.
 - d. Capable of manual configuration via a console RS-232 port.
- B. Gateways:
 1. Perform bidirectional protocol translation from one non-CTA-709.1-D protocol to CTA-709.1-D.
 2. Incorporate a network connection to TP/FT-10 network in accordance with CTA-709.3 and a connection for non-CTA-709.1-D network.

2.24 WIRELESS ROUTERS FOR OPERATOR INTERFACE

- A. Dual-Band Wireless Routers:
 1. Description: High-speed, dual-band router with integral Ethernet ports and USB port.
 2. Technology: IEEE 802.11; 2.4 and 5 GHz speed bands.
 3. Wireless Speed: Up to [300] <Insert number> Mbps on 2.4 GHz band and up to [2400] <Insert number> Mbps on 5 GHz band.
 4. Compatibility: IEEE 802.11 ac wireless devices.
 5. Ethernet Ports: Four, gigabit (1000 Mbps).
 6. USB Port: One, USB 2.0 or 3.0.
 7. Wireless Security: Wi-Fi Protected Access (WPA) and WPA2 in accordance with IEEE 802.11.
- B. Tri-Band Wireless Routers:
 1. Description: High-speed, tri-band router with integral Ethernet ports and USB port.
 2. Technology: IEEE 802.11; 2.4 and 5 GHz speed bands.

3. Wireless Speed: Up to [600] <Insert number> Mbps on 2.4 GHz band and up to [4800] <Insert number> Mbps on two 5 GHz bands.
4. Compatibility: IEEE 802.11 [ac] [or] [ax] wireless devices.
5. Ethernet Ports: [Four] <Insert number>, gigabit [1000] [2500] <Insert number> Mbps.
6. USB Port: One, USB 2.0 or 3.0.
7. Wireless Security: Wi-Fi Protected Access (WPA) and WPA2 in accordance with IEEE 802.11.

2.25 DDC CONTROLLERS

- A. DDC system consisting of a combination of network controllers, programmable application controllers, and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers to perform monitoring, control, energy optimization, and other requirements indicated.
- C. DDC controllers are to use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller is capable of full and complete operation as a completely independent unit and as a part of DDC system wide distributed network.
- E. Environment Requirements:
 1. Controller hardware suitable for anticipated ambient conditions.
 2. Controllers located in conditioned space rated for operation at [32 to 120 deg F (0 to 50 deg C)] <Insert temperature range>.
 3. Controllers located outdoors rated for operation at [40 to 150 deg F (4 to 65 deg C)] <Insert temperature range>.
- F. Power and Noise Immunity:
 1. Operate controller at 90 to 110 percent of nominal voltage rating and perform an orderly shutdown below 80 percent of nominal voltage.
 2. Protect against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches (900 mm) of enclosure.
- G. DDC Controller Spare Processing Capacity:
 1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
 - a. Network Controllers: [50] [60] [70] <Insert number> percent.
 - b. Programmable Application Controllers: Not less than [60] [70] [80] <Insert number> percent.
 - c. Application-Specific Controllers: Not less than [70] [80] [90] <Insert number> percent.
 2. Memory for DDC controller's operating system and database are to include the following:
 - a. Monitoring and control.
 - b. Energy management, operation, and optimization applications.
 - c. Alarm management.
 - d. Historical trend data of all connected I/O points.
 - e. Maintenance applications.
 - f. Operator interfaces.
 - g. Monitoring of manual overrides.

- H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:
1. Network Controllers:
 - a. [10] [20] <Insert number> percent of each AI, AO, BI, and BO point connected to controller.
 - b. Minimum Spare I/O Points per Controller:
 - 1) AIs: [Two] [Three] <Insert number>.
 - 2) AOs: [Two] [Three] <Insert number>.
 - 3) BIs: [Three] [Five] <Insert number>.
 - 4) BOs: [Three] [Five] <Insert number>.
 - 5) Option to provide universal I/O to meet spare requirements.
 2. Programmable Application Controllers:
 - a. [10] [20] <Insert number> percent of each AI, AO, BI, and BO point connected to controller.
 - b. Minimum Spare I/O Points per Controller:
 - 1) AIs: [Two] [Three] <Insert number>.
 - 2) AOs: [Two] [Three] <Insert number>.
 - 3) BIs: [Three] [Five] <Insert number>.
 - 4) BOs: [Three] [Five] <Insert number>.
 - 5) Option to provide universal I/O to meet spare requirements.
 3. Application-Specific Controllers:
 - a. [10] <Insert number> percent of each AI, AO, BI, and BO point connected to controller.
 - b. Minimum Spare I/O Points per Controller:
 - 1) AIs: [One] [Two] <Insert number>.
 - 2) AOs: [One] [Two] <Insert number>.
 - 3) BIs: [One] [Two] <Insert number>.
 - 4) BOs: [One] [Two] <Insert number>.
 - 5) Option to provide universal I/O to meet spare requirements.
- I. Maintenance and Support: Include the following features to facilitate maintenance and support:
1. Mount microprocessor components on circuit cards for ease of removal and replacement.
 2. Means to quickly and easily disconnect controller from network.
 3. Means to quickly and easily access connect to field test equipment.
 4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.
- J. General Requirements for CTA-709.1-D DDC Controllers:
1. LonMark certified.
 2. Distinguishable and accessible switch, button, or pin, when pressed is to broadcast its 48-bit Node ID and Program ID over network.
 3. TP/FT-10 transceiver in accordance with CTA-709.3 and connections for TP/FT-10 control network wiring.
 4. TP/XF-1250 transceiver in accordance with CTA-709.3 and connections for TP/XF-1250 control network wiring.
 5. Communicate using CTA-709.1-D protocol.
 6. Controllers configured into subnets, as required, to comply with performance requirements indicated.

7. Network communication through LNS network management and database standard for CTA-709.1-D network devices.
 8. Locally powered, not powered through network connection.
 9. Functionality required to support applications indicated including, but not limited to, the following:
 - a. I/Os indicated and as required to support sequence of operation and application in which it is used. SNVTs to have meaningful names identifying the value represented by SNVT. Unless SNVT of an appropriate engineering type is unavailable, all network variables to be of SNVT with engineering units appropriate to value the variable represents.
 - b. Configurable through SCPTs defined in LonMark SCPT List, operator-defined UCPTs, network configuration inputs (NCIs) of SNVT type defined in LonMark SNVT List, NCIs of an operator-defined network variable type, or hardware settings on controller itself for all settings and parameters used by application in which it is used.
 10. Programmable controllers comply with "LonMark Interoperability Guidelines" and have LonMark certification.
- K. I/O Point Interface:
1. Connect hardwired I/O points to network, programmable application, and application-specific controllers.
 2. Protect I/O points so shorting of point to itself, to another point, or to ground will not damage controller.
 3. Protect I/O points from voltage up to 24 V of any duration so that contact will not damage controller.
 4. AIs:
 - a. Include monitoring of low-voltage (0 to 10 V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
 - b. Compatible with, and field configurable to, sensor and transmitters installed.
 - c. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of [8] [12] **<Insert value>** bits or better to comply with accuracy requirements indicated.
 - d. Signal conditioning including transient rejection for each AI.
 - e. Capable of being individually calibrated for zero and span.
 - f. Incorporate common-mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
 - g. External conversion resistors are not permitted.
 5. AOs:
 - a. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of [8] [12] **<Insert value>** bits or better to comply with accuracy requirements indicated.
 - b. Output signals range of [4 to 20 mA dc] [or] [0 to 10 V dc] as required to include proper control of output device.
 - c. Capable of being individually calibrated for zero and span.
 - d. Drift is to be not greater than 0.4 percent of range per year.
 - e. External conversion resistors are not permitted.
 6. BIs:
 - a. Accept contact closures and ignore transients of less than 5 ms duration.
 - b. Isolate and protect against an applied steady-state voltage of up to 180 V ac peak.

- c. Include a wetting current of at least 12 mA to be compatible with commonly available control devices and protected against effects of contact bounce and noise.
 - d. Sense "dry contact" closure without external power (other than that provided by controller) being applied.
 - e. Pulse accumulation input points complying with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Include buffer to totalize pulses. Pulse accumulator is to accept rates of at least 20 pulses per second. Reset the totalized value to zero on operator's command.
7. BOs:
- a. Include relay contact closures or triac outputs for momentary and maintained operation of output devices.
 - 1) Relay contact closures to have a minimum duration of 0.1 second and at least 180 V of isolation.
 - 2) Include electromagnetic interference suppression on all output lines to limit transients to non-damaging levels.
 - 3) Minimum contact rating to be 1 A at 24 V ac.
 - 4) Triac outputs to have at least 180 V of isolation and minimum contact rating of 1 A at 24 V ac.
 - b. Include BOs with two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
 - c. BOs to be selectable for either normally open or normally closed operation.
 - d. Include tristate outputs (two coordinated BOs) for control of three-point, floating-type electronic actuators without feedback.
 - e. Limit use of three-point floating devices to VAV terminal unit control applications[, **and other applications indicated on Drawings,**] <Insert applications>. Control algorithms to operate actuator to one end of its stroke once every [12] [24] <Insert time> hours for verification of operator tracking.

2.26 NETWORK CONTROLLERS

A. General:

- 1. Include adequate number of controllers to achieve performance indicated.
- 2. Provide one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
- 3. Include enough memory to support its operating system, database, and programming requirements with spare memory indicated.
- 4. Share data between networked controllers and other network devices.
- 5. Operating system of controller to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
- 6. Include network controllers with a real-time clock.
- 7. Controller to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller is to assume a predetermined failure mode and generate an alarm notification.
- 8. Make controllers fully programmable.

B. Communication:

- 1. Network controllers communicate with other devices on DDC system [Level 1] <Insert level> network.
- 2. Network controller to also perform routing if connected to network of programmable application controllers and application-specific controllers.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to [**desktop operator's workstation**] [**portable operator's workstation**] [**POT**] [**or**] [**mobile device**].
2. Local Keypad and Display:
 - a. Equip controller with local keypad and digital display for interrogating and editing data.
 - b. Use of keypad and display requires a security password.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Maintain Basic Input Output System (BIOS) and programming information in event of power loss for at least [72] [96] <Insert number> hours.

2.27 PROGRAMMABLE APPLICATION CONTROLLERS

A. General:

1. Include adequate number of controllers to achieve performance indicated.
2. Provide enough memory to support its operating system, database, and programming requirements with spare memory indicated.
3. Share data between networked controllers and other network devices.
4. Include controller with operating system to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Include controllers [**that perform scheduling**] with a real-time clock.
6. Controller is to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller assumes a predetermined failure mode and generates an alarm notification.
7. Fully programmable.

B. Communication:

1. Programmable application controllers are to communicate with other devices on network.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to [**desktop operator's workstation**] [**portable operator's workstation**] [**POT**] [**or**] [**mobile device**].
2. Local Keypad and Display:
 - a. Equip controller with local keypad and digital display for interrogating and editing data.
 - b. Protect use of keypad and display by security password.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Maintain BIOS and programming information in event of power loss for at least 72 hours.

2.28 APPLICATION-SPECIFIC CONTROLLERS

- A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment or system. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
 - 1. Capable of standalone operation and continued control functions without being connected to network.
 - 2. Share data between networked controllers and other network devices.
- B. Communication: Application-specific controllers are to communicate with other application-specific controllers and devices on network, and to programmable application controllers and network controllers.
- C. Operator Interface: Equip controllers with a service communications port for connection to **[desktop workstation] [portable operator's workstation] [POT] [or] [mobile device].****[Connection is to extend to port on space temperature sensor that is connected to controller.]**
- D. Serviceability:
 - 1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
 - 2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 - 3. Use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.29 CONTROLLER SOFTWARE

- A. General:
 - 1. Software applications are to reside and operate in controllers. Edit applications through operator workstations **[or mobile devices]**.
 - 2. Identify I/O points by up to **[30] <Insert number>**-character point name and up to **[16] <Insert number>**-character point descriptor. Use same names throughout, including at operator workstations.
 - 3. Execute control functions within controllers using DDC algorithms.
 - 4. Configure controllers to use stored default values to ensure fail-safe operation. Use default values when there is a failure of a connected input instrument or loss of communication of a global point value.
- B. Security:
 - 1. Secure operator access using individual security passwords and user names.
 - 2. Passwords restrict operator to points, applications, and system functions as assigned by system manager.
 - 3. Record operator log-on and log-off attempts.
 - 4. Protect from unauthorized use by automatically logging off after last keystroke. Make the delay time operator-definable.
- C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule is to consist of the following:
 - 1. Weekly Schedules:
 - a. Include separate schedules for each day of week.
 - b. Each schedule should include capability for start, stop, optimal start, optimal stop, and night economizer.

- c. Each schedule may consist of up to 10 events.
 - d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
- 2. Exception Schedules:
 - a. Include ability for operator to designate any day of the year as an exception schedule.
 - b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
- 3. Holiday Schedules:
 - a. Include capability for operator to define up to 99 special or holiday schedules.
 - b. Place schedules on scheduling calendar with ability to repeated each year.
 - c. Operator able to define length of each holiday period.
- D. System Coordination:
 - 1. Include standard application for proper coordination of equipment.
 - 2. Include operator with a method of grouping together equipment based on function and location.
 - 3. Include groups that may be for use in scheduling and other applications.
- E. Binary Alarms:
 - 1. Set each binary point to alarm based on operator-specified state.
 - 2. Include capability to automatically and manually disable alarming.
- F. Analog Alarms:
 - 1. Provide each analog object with both high and low alarm limits.
 - 2. Include capability to automatically and manually disable alarming.
- G. Alarm Reporting:
 - 1. Include ability for operators to determine action to be taken in event of an alarm.
 - 2. Route alarms to appropriate operator workstations based on time and other conditions.
 - 3. Include ability for alarms to start programs, print, be logged in event logs, generate custom messages, and display graphics.
- H. Remote Communication:
 - 1. Include ability for system to notify operators by phone message, text message, and email in event of an alarm.
- I. Electric Power Demand Limiting:
 - 1. Monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
 - 2. Predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
 - 3. Accomplish demand reduction by the following means:
 - a. Reset air-handling-unit supply temperature set points.
 - b. Reset space temperature set points.
 - c. De-energize equipment based on priority.

4. Base demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables on the means by which electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:
 - a. Addition and deletion of loads controlled.
 - b. Changes in demand intervals.
 - c. Changes in demand limit for meter(s).
 - d. Maximum shutoff time for equipment.
 - e. Minimum shutoff time for equipment.
 - f. Select rotational or sequential shedding and restoring.
 - g. Shed and restore priority.
7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly, and annual basis:
 - a. Total electric consumption.
 - b. Peak demand.
 - c. Date and time of peak demand.
 - d. Daily peak demand.
- J. Maintenance Management: Monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.
- K. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.
- L. Control Loops:
 1. Support any of the following control loops, as applicable to control required:
 - a. Two-position (on/off, open/close, slow/fast) control.
 - b. Proportional control.
 - c. Proportional plus integral (PI) control.
 - d. Proportional plus integral plus derivative (PID) control.
 - 1) Include PID algorithms with direct or reverse action and anti-windup.
 - 2) Algorithm to calculate a time-varying analog value used to position an output or stage a series of outputs.
 - 3) Make controlled variable, set point, and PID gains operator-selectable.
 - e. Adaptive (automatic tuning).
- M. Staggered Start: Prevent all controlled equipment from simultaneously restarting after a power outage. Make the order which equipment (or groups of equipment) is started, along with the time delay between starts, operator-selectable.
- N. Energy Calculations:
 1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
 2. Include algorithm that calculates a sliding-window average (rolling average). Make algorithm flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
 3. Include algorithm that calculates a fixed-window average. Use a digital input signal to define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

- O. Anti-Short Cycling:
 - 1. Protect BO points from short cycling.
 - 2. Feature to allow minimum on-time and off-time to be selected.
- P. On and Off Control with Differential:
 - 1. Include algorithm that allows BO to be cycled based on a controlled variable and set point.
 - 2. Use direct- or reverse-acting algorithm and incorporate an adjustable differential.
- Q. Run-Time Totalization:
 - 1. Include software to totalize run-times for all BI **[and BO]**points.
 - 2. Assign a high run-time alarm, if required, by operator.

2.30 ENCLOSURES

- A. General:
 - 1. House each controller and associated control accessories in **[single]**enclosure. Enclosure is to serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies, and transformers.
 - 2. Do not house more than one controller in single enclosure.
 - 3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
 - 4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
 - 5. Individual, wall-mounted, single-door enclosures maximum of **[36 inches (900 mm)]** **<Insert dimension>** wide and **[48 inches (1200 mm)]** **[60 inches (1500 mm)]** **<Insert dimension>** high.
 - 6. Individual, wall-mounted, double-door enclosures maximum of **[60 inches (1500 mm)]** **<Insert dimension>** wide and **[36 inches (900 mm)]** **<Insert dimension>** high.
 - 7. Freestanding enclosures maximum of **[48 inches (1200 mm)]** **<Insert dimension>** wide and **[72 inches (1800 mm)]** **<Insert dimension>** high.
 - 8. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
 - 9. Supply each enclosure with complete set of as-built schematics, tubing, and wiring diagrams and product literature located in pocket on inside of door. **[For enclosures with windows, include pocket on bottom of enclosure.]**
- B. Internal Arrangement:
 - 1. Arrange internal layout of enclosure to group and protect **[pneumatic,]**electric, and electronic components associated with controller, but not an integral part of controller.
 - 2. Arrange layout to group similar products together.
 - 3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
 - 4. Factory or shop install products, tubing, cabling, and wiring complying with requirements and standards indicated.
 - 5. Terminate field cable and wire using heavy-duty terminal blocks.
 - 6. Include spare terminals, equal to not less than **[10] [20] <Insert number>** percent of used terminals.
 - 7. Include spade lugs for stranded cable and wire.
 - 8. Install maximum of two wires on each side of terminal.
 - 9. Include enclosure field electric power supply with toggle-type switch located at entrance inside enclosure to disconnect power.

10. Include enclosure with line-voltage nominal 20 A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with 5 A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with **[engraved, laminated phenolic]** nameplates (black letters on a white background). Nameplates are to have at least 1/4-inch- (6-mm-) high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with continuous removable cover.
14. Label each end of cable, wire, and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least **[15] [25] <Insert number>** percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction, and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

D. Wall-Mounted, NEMA 250, Type 1:

1. NRTL listed in accordance with UL 50 or UL 50E.
2. Construct enclosure of steel, not less than the following:
 - a. Enclosure Size Less Than 24 Inches (600 mm): **[0.053 inch (1.35 mm)] [or] [0.067 inch (1.7 mm)]** thick.
 - b. Enclosure Size 24 Inches (600 mm) and Larger: **[0.067 inch (1.7 mm)] [or] [0.093 inch (2.36 mm)]** thick.
3. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior Color: **[White] [Gray] [Selected by Architect] [Manufacturer's standard] <Insert color>**.
 - b. Interior Color: **[White] [Gray] [Manufacturer's standard]**.
4. Hinged door full size of front face of enclosure and supported using the following:
 - a. Enclosures Sizes Less Than 36 Inches (900 mm) Tall: Multiple butt hinges.
 - b. Enclosures Sizes 36 Inches (900 mm) Tall and Larger: Continuous piano hinges.

5. Removable internal panel with **[white] [or] [gray]** polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Size Less Than 24 Inches (600 mm): **[Solid] [or] [perforated]** steel, 0.053 inch (1.35 mm) thick.
 - b. Size 24 Inches (600 mm) and Larger: Solid **[aluminum, 0.10 inch (3 mm)] [or] [steel, 0.093 inch (2.36 mm)]** thick.
 6. Internal panel mounting hardware, grounding hardware, and sealing washers.
 7. Grounding stud on enclosure body.
 8. Thermoplastic pocket on inside of door for record Drawings and Product Data.
- E. Wall-Mounted, NEMA 250, Types 4 and 12:
1. NRTL listed in accordance with UL 508A.
 2. Seam and joints are continuously welded and ground smooth.
 3. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
 4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
 5. Single-door enclosure sizes up to 60 inches tall by 36 inches wide (1500 mm tall by 900 mm wide).
 6. Double-door enclosure sizes up to 36 inches tall by 60 inches wide (900 mm tall by 1500 mm wide).
 7. Construct enclosure of steel, not less than the following:
 - a. Size Less Than 24 Inches (600 mm): 0.053 inch (1.35 mm) or 0.067 inch (1.7 mm) thick.
 - b. Size 24 Inches (600 mm) and Larger: 0.067 inch (1.7 mm) thick.
 8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior Color: Manufacturer's standard.
 - b. Interior Color: Manufacturer's standard.
 9. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
 - a. Sizes through 24 Inches (600 mm) Tall: Two hinges.
 - b. Sizes between 24 Inches (600 mm) through 48 Inches (1200 mm) Tall: Three hinges.
 - c. Sizes Larger Than 48 Inches (1200 mm) Tall: Four hinges.
 10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
 - a. Single-door enclosures 48 inches (1200 mm) and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.
 11. Removable internal panel with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Size Less Than 24 Inches (600 mm): Solid or perforated steel, 0.053 inch (1.35 mm) thick.
 - b. Size 24 Inches (600 mm) and Larger: Solid aluminum, 0.10 inch (3 mm) or steel, 0.093 inch (2.36 mm) thick.
 12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
 13. Grounding stud on enclosure body.

14. Thermoplastic pocket on inside of door for record Drawings and Product Data.

F. Wall-Mounted, NEMA 250, Type 4X-SS:

1. NRTL listed in accordance with UL 508A.
2. Seams and joints are continuously welded and ground smooth.
3. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
4. Construct enclosure of Type 304 or Type 316L stainless steel, not less than the following:
 - a. Size Less Than 24 Inches (600 mm): 0.053 inch (1.35 mm) thick.
 - b. Size 24 Inches (600 mm) and Larger: 0.067 inch (1.7 mm) thick.
5. Outside body and door of enclosure with brushed No. 4 finish.
6. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
 - a. Sizes through 24 Inches (600 mm) Tall: Two hinges.
 - b. Sizes between 24 Inches (600 mm) through 48 Inches (1200 mm) Tall: Three hinges.
 - c. Sizes Larger Than 48 Inches (1200 mm) Tall: Four hinges.
7. Corner-formed door, full size of enclosure face, supported using continuous piano hinge full length of door.
8. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquidtight, Type 304 or Type 316L stainless steel handle with integral locking mechanism.
9. Removable internal panel of 0.093-inch (2.36-mm) stainless steel.
10. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
11. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
12. Include enclosure with stainless steel mounting brackets.

G. Freestanding, NEMA 250, Type 1:

1. NRTL listed in accordance with UL 508A.
2. Seams and joints are continuously welded and ground smooth.
3. Externally formed body flange around perimeter of enclosure face.
4. Single-door enclosure sizes up to 84 inches tall by 36 inches wide (2100 mm tall by 900 mm wide).
5. Double-door enclosure sizes up to 84 inches tall by 72 inches wide (2100 mm tall by 900 mm wide).
6. Construct enclosure of steel, not less than 0.067 inch (1.7 mm) thick.
7. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior Color: Manufacturer's standard.
 - b. Interior Color: Manufacturer's standard.
8. Corner-formed flush door, full size of enclosure face, supported using four concealed hinges with easily removable hinge pins.
9. Double-door enclosures with overlapping door design to include unobstructed full-width access.
10. Doors with three-point (top, middle, and bottom) latch system with single heavy-duty handle and integral locking mechanism.
11. Removable back covers.
12. Removable solid steel internal panel, 0.093 inch (2.36 mm) thick, with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.

13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
 14. Grounding stud on enclosure body.
 15. Thermoplastic pocket on inside of door for record Drawings and Product Data.
 16. Nominal 4-inch- (100-mm-) tall integral lifting base, not less than 0.123 inch (3.12 mm) thick, with predrilled holes for attachment to mounting surface.
 17. Equip each top end of enclosure with lifting tabs, not less than 0.172 inch (4.37 mm) thick, or not less than two lifting eyes.
 18. Internal rack-mount shelves and angles, as required by application.
- H. Freestanding, NEMA 250, Types 4 and 12:
1. NRTL listed in accordance with UL 508A.
 2. Seams and joints are continuously welded and ground smooth.
 3. Externally formed body flange around perimeter of enclosure face.
 4. Type 12 Enclosure Sizes:
 - a. Single-door enclosure sizes up to 90 inches tall by 36 inches wide (2250 mm tall by 900 mm wide).
 - b. Double-door enclosure sizes up to 90 inches tall by 72 inches wide (2250 mm tall by 900 mm wide).
 5. Type 4 Enclosure Sizes:
 - a. Single-door enclosure sizes up to 72 inches tall by 36 inches wide (1800 mm tall by 900 mm wide).
 - b. Double-door enclosure sizes larger than 36 inches (900 mm) wide.
 6. Construct enclosure of steel, not less than 0.093 inch (2.36 mm) thick.
 7. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior Color: Manufacturer's standard.
 - b. Interior Color: Manufacturer's standard.
 8. Corner-formed door with continuous perimeter oil-resistant gasket supported using continuous piano hinge full length of door.
 9. Doors fitted with three-point (top, middle, and bottom) latch system with latching rod rollers and single, heavy-duty, oiltight handle with integral locking mechanism.
 10. Removable solid steel internal panel, 0.093 inch (2.36 mm) thick, with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 11. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
 12. Grounding stud on enclosure body.
 13. Thermoplastic pocket on inside of door for record Drawings and Product Data.
 14. Equip top of enclosure with no fewer than two lifting eyes.
 15. Internal rack-mount shelves and angles, as required by application.
- I. Freestanding, NEMA 250, Type 4X-SS:
1. NRTL listed in accordance with UL 508A.
 2. Seams and joints are continuously welded and ground smooth.
 3. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
 4. Construct enclosure of Type 304 or Type 316L stainless steel, not less than the following:
 - a. Size Less Than 24 Inches (600 mm): 0.053 inch (1.35 mm) thick.
 - b. Size 24 Inches (600 mm) and Larger: 0.067 inch (1.7 mm) thick.
 5. Outside enclosure and door of enclosure with brushed No. 4 finish.

6. Doors:
 - a. Single-door enclosure sizes up to 36 inches (900 mm) wide.
 - b. Double-door enclosure sizes larger than 36 inches (900 mm) wide.
 - c. Corner-formed door(s) with continuous perimeter oil-resistant gasket, full size of enclosure face, supported using continuous piano hinge full length of door.
 - d. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquidtight, Type 304 or Type 316L stainless steel handle with integral locking mechanism.
 7. Removable internal panel of 0.093-inch (2.36-mm) stainless steel.
 8. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
 9. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
 10. Include enclosure with stainless steel mounting brackets.
 11. Thermoplastic pocket on inside of door for record Drawings and Product Data.
 12. Equip top of enclosure with no fewer than two lifting eyes.
 13. Internal rack-mount shelves and angles, as required by application.
- J. Accessories:
1. Electric Heater:
 - a. Aluminum housing with brushed finish.
 - b. Thermostatic control with adjustable set point from 0 to 100 deg F (minus 18 to 38 deg C).
 - c. Capacity: 100, 200, 400, and 800 W, as required by application.
 - d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.
 2. Ventilation Fans, Filtered Intake, and Exhaust Grilles:
 - a. Number and size of fans, filters, and grilles, as required by application.
 - b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
 - c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
 - d. Thermostatic control with adjustable set point from 32 to 140 deg F (0 to 60 deg C).
 - e. Airflow Capacity at Zero Pressure:
 - 1) 4-Inch (100-mm) Fan: 100 cfm (47 L/s).
 - 2) 6-Inch (150-mm) Fan: 240 cfm (113 L/s).
 - 3) 10-Inch (250-mm) Fan: 560 cfm (264 L/s).
 - f. Maximum operating temperature of 158 deg F (70 deg C).
 - g. 4-inch (100-mm) fan thermally protected and provided with permanently lubricated ball-bearings.
 - h. 6- and 10-inch (150- and 250-mm) fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
 - i. Dynamically balanced impellers molded from polycarbonate material.
 - j. Fan furnished with power cord and polarized plug for power connection.
 - k. Fan brackets, finger guards, and mounting hardware provided with fans to complete installation.
 - l. Removable Intake and Exhaust Grilles: ABS plastic or stainless steel, of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.

- m. Filters for NEMA 250, Type 1 Enclosures: Washable foam or aluminum, of size to match intake grille.
- n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of size to match intake grille.
- 3. Air Conditioner:
 - a. Electric-powered, self-contained, air-conditioning unit specially designed for electrical enclosures to maintain temperature inside enclosure below ambient temperature outside enclosure.
 - b. Thermostatic control with adjustable set point from 60 to 120 deg F (16 to 49 deg C).
 - c. Enclosure side or top mounting with unit capacity, as required by application.
 - d. Designed for closed-loop cooling with continuous operation in ambient environments up to 125 deg F (52 deg C).
 - e. HFC refrigerant.
 - f. Reusable and washable air filter.
 - g. High-performance, industrial-grade, and high-efficiency fans.
 - h. Furnished with power cord and polarized plug for power connection.
 - i. Condensate management system with base pan side drain.
 - j. Mounting hardware, gaskets, mounting template, and instruction manual furnished with unit.
 - k. Outdoor units equipped with head pressure control for low ambient operation, compressor heater, coated condenser coil, and thermostat.
- 4. Thermoelectric Humidifier:
 - a. ABS plastic enclosure.
 - b. Capacity of 8 oz. (0.24 L) of water per 24 hours.
 - c. Built-in drain captures moisture and plastic hose directs moisture to outside enclosure through a drain.
 - d. Controlled to maintain enclosure relative humidity at adjustable set point.
 - e. Unit power supply is internally wired to enclosure electrical power source.
- 5. Framed Fixed Window Kit for NEMA 250, Types 4, 4X, and 12 Enclosures:
 - a. 0.25-inch- (6-mm-) thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
 - b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
 - c. Window kit to be factory or shop installed before shipment to Project.
- 6. Frameless Fixed Window Kit for NEMA 250, Type 1 Enclosures:
 - a. 0.125-inch- (3-mm-) thick, polycarbonate window mounted in enclosure door material.
 - b. Window attached to door with screw fasteners and continuous strip of high-strength, double-sided tape around window perimeter.
 - c. Window kit is factory or shop installed before shipment to Project.
- 7. Frame Fixed or Hinged Window Kit for NEMA 250, Types 1 and 12 Enclosures:
 - a. 0.25-inch- (6-mm-) thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
 - b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
 - c. Window kit to be factory or shop installed before shipment to Project.
- 8. Bar handle with keyed cylinder lock set.

2.31 RELAYS

A. General-Purpose Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allen Bradley; by Rockwell Automation.
 - b. Eaton.
 - c. IDEC Corporation.
 - d. Omron Americas.
 - e. Siemens Industry, Inc., Building Technologies Division.
 - f. Square D; Schneider Electric USA.
2. NRTL listed.
3. Heavy-duty, electromechanical type; rated for at least 10 A at 250 V ac and 60 Hz.
4. SPDT, DPDT, or three-pole double-throw, as required by control application.
5. Plug-in-style relay with 8-pin octal or multiblade plug for DPDT relays and 11-pin octal or multiblade plug for three-pole double-throw relays.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a polycarbonate dust-tight cover.
8. Include LED indication and push-to-test button to test manual operation of relay without power on coil.
9. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: **[15] [20] <Insert value>** ms or less.
 - d. Dropout Time: **[10] [20] <Insert value>** ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: **[50] [10] <Insert number>** percent of nominal rated voltage.
 - g. Power Consumption: **[2] [5]** VA or less.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).
10. Equip relays with coil transient suppression to limit transients to non-damaging levels.
11. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
12. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

B. Multifunction Time-Delay Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allen Bradley; by Rockwell Automation.
 - b. Eaton.
 - c. IDEC Corporation.
 - d. Omron Americas.
 - e. Siemens Industry, Inc., Building Technologies Division.
 - f. Square D; Schneider Electric USA.
2. NRTL listed.
3. Continuous-duty type, rated for at least 10 A at 240 V ac and 60 Hz.
4. Relay with up to **[4] [8] <Insert number>** programmable functions to provide on/off delay, interval, and recycle timing functions.
5. Plug-in-style relay with either multi-pin or blade plug.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a dust-tight cover.

8. Include knob and dial scale for alternative digital interface for setting delay time.
9. Visual Status Indication: Power "On"[**and Output "On"**] status.
10. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
 - d. Repeatability: Within 2 percent.
 - e. Recycle Time: 45 ms.
 - f. Minimum Pulse-Width Control: 50 ms.
 - g. Power Consumption: 5 VA or less.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).
11. Equip relays with transient suppression to limit transients to non-damaging levels.
12. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
13. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

C. Latching Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allen Bradley; by Rockwell Automation.
 - b. Eaton.
 - c. IDEC Corporation.
 - d. Omron Americas.
 - e. Siemens Industry, Inc., Building Technologies Division.
 - f. Square D; Schneider Electric USA.
2. NRTL listed.
3. Continuous-duty type, rated for at least 10 A at 250 V ac and 60 Hz.
4. SPDT, DPDT, or three-pole double-throw, as required by control application.
5. Plug-in-style relay with either multi-pin or blade plug.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a polycarbonate dust-tight cover.
8. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: **[15] [20] <Insert value>** ms or less.
 - d. Dropout Time: **[10] [20] <Insert value>** ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: **[50] [10] <Insert number>** percent of nominal rated voltage.
 - g. Power Consumption: **[2] [5] <Insert value>** VA or less.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).
9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

D. Current Sensing Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. Functional Devices Inc.
 - c. NK Technologies.
 - d. Square D; Schneider Electric USA.
2. NRTL listed.
3. Monitors ac current.
4. Independent adjustable controls for pickup and dropout current.
5. Energized when supply voltage is present and current is above pickup setting.
6. De-energizes when monitored current is below dropout current.
7. Dropout current is adjustable from 50 to 95 percent of pickup current.
8. Visual indication of contact status.
9. Include current transformer, if required for application.
10. House current sensing relay and current transformer if required in its own enclosure. Use NEMA 250, Type 1 or Type 12 enclosure for indoors applications and NEMA 250, Type 4 or Type 4X for outdoor applications.

E. Combination On-Off Status Sensor and On-Off Control Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Functional Devices Inc.
 - b. Veris Industries.
2. Description:
 - a. On-off control and on-off status indication in a single device.
 - b. LED status indication of activated relay and current trigger.
 - c. Closed-Open-Auto override switch located on the load side of relay.
3. Performance:
 - a. Ambient Temperature: Minus 30 to 140 deg F (Minus 34 to 60 deg C).
 - b. Voltage Rating: Single-phase loads rated for 300 V ac. Three-phase loads rated for 600 V ac.
4. Status Indication:
 - a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
 - b. Current Sensor Range: As required by application.
 - c. Current Set Point: Fixed or adjustable, as required by application.
 - d. Current Sensor Output:
 - 1) Solid-state, SPDT contact rated for 30 V ac and dc and for 0.4 A.
 - 2) Solid-state, SPDT contact rated for 120 V ac and 1.0 A.
 - 3) Analog, 0 to 5 or 10 V dc.
 - 4) Analog, 4 to 20 mA, loop powered.
5. Relay: SPDT, continuous-duty coil; rated for 10-million mechanical cycles.
6. Enclosure: NEMA 250, [Type 1] [Type 12] enclosure for indoor applications; NEMA 250, [Type 4] [Type 4X] enclosure for outdoor applications.

2.32 ELECTRICAL POWER DEVICES

A. Control Transformers:

1. Sizing Criteria: Size control transformers for total connected load, plus additional **[25] [50]** percent of connected load for future spare capacity.
2. Transformer Minimum Capacity: **[40] [100]** VA.
3. Protection: Provide transformers with both primary and secondary fuses. **[Integral circuit breaker is acceptable in lieu of fuses.]**
4. Enclosure: House control transformers in NEMA 250 enclosures, type as indicated in "Performance Requirements" Article for application.

B. Power-Line Conditioners:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. Emerson Electric Co., Automation Solutions.
 - c. SolaHD; Emerson Electric Co., Automation Solutions.
2. General Power-Line Conditioner Requirements:
 - a. Design to ensure maximum reliability, serviceability, and performance.
 - b. Overall function of power-line conditioner is to receive raw, polluted electrical power and purify it for use by electronic equipment. Power-line conditioner is to provide isolated, regulated, transient, and noise-free sinusoidal power to loads served.
3. Standards: NRTL listed per UL 1012.
4. Performance:
 - a. Single phase, continuous, 100 percent duty rated kVA/kW capacity. Design to supply power for linear or nonlinear, high crest factor, resistive and reactive loads.
 - b. Automatically regulate output voltage to within 2 percent or better with input voltage fluctuations of plus 10 to minus 20 percent of nominal when system is loaded 100 percent. Use Variable Range Regulation to obtain improved line voltage regulation when operating under less than full load conditions.
 - 1) At 75 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 35 percent of nominal.
 - 2) At 50 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 40 percent of nominal.
 - 3) At 25 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 45 percent of nominal.
 - c. With input voltage distortion of up to 40 percent, limit the output voltage sine wave to maximum harmonic content of 5 percent.
 - d. Automatically regulate output voltage to within 2.5 percent when load (resistive) changes from zero to 100 to zero percent.
 - e. Output voltage returns to 95 percent of nominal level within two cycles and to 100 percent within three cycles when output is taken from no load to full-resistive load, or vice versa. Recovery from partial resistive load changes is corrected in a shorter period.
 - f. K Factor: 30, designed to operate with nonlinear, non-sinusoidal, high crest factor loads without overheating.

- g. Input power factor within 0.95 approaching unity with load power factor as poor as 0.6.
 - h. Attenuate load-generated odd current harmonics 23 dB at the input.
 - i. Electrically isolate the primary from the secondary. Meet isolation criteria as defined in NFPA 70, Article 250-5D.
 - j. Lighting and Surge Protection: Compares to UL 1449 rating of 330 V when subjected to Category B3 (6000 V/3000 A) combination waveform as established by IEEE C62.41.1 and IEEE C62.41.2.
 - k. Common-mode noise attenuation of 140 dB.
 - l. Transverse-mode noise attenuation of 120 dB.
 - m. With loss of input power for up to 16.6 ms, output sine wave remains at usable ac voltage levels.
 - n. Reliability of 200,000 hours' MTBF.
 - o. At full load, when measured at 1 m distance, audible noise is not to exceed 54 dB.
 - p. Approximately 92 percent efficient at full load.
5. Transformer Construction:
- a. Ferroresonant, dry type, convection cooled, 600 V class. Transformer windings of Class H (220 deg C) insulated copper.
 - b. Use Class H installation system throughout with operating temperatures not to exceed 150 deg C over a 40 deg C ambient temperature.
 - c. Configure transformer primary for multi-input voltage. Include input terminals for source conductors and ground.
 - d. Manufacture transformer core using M-6 grade, grain-oriented, stress-relieved transformer steel.
 - e. Configure transformer secondary in 240/120 V split with 208 V tap or straight 120 V, depending on power output size.
 - f. Electrically isolate the transformer secondary windings from primary windings. Bond neutral conductor to cabinet enclosure and output neutral terminal.
 - g. Include interface terminals for output power hot, neutral, and ground conductors.
 - h. Label leads, wires, and terminals to correspond with circuit wiring diagram.
 - i. Vacuum impregnate transformer with epoxy resin.
6. Cabinet Construction:
- a. Design for panel or floor mounting.
 - b. NEMA 250, Type 1 or Type 2 enclosure for indoor applications. NEMA 250, Type 3R for outdoor applications.
 - c. Manufacture the cabinet from heavy gauge steel complying with UL 50 or UL 508A.
 - d. Include textured baked-on paint finish.
- C. DC Power Supplies:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acopian Technical Company.
 - b. Emerson Electric Co., Automation Solutions.
 - c. IDEC Corporation.
 - d. Omron Americas.
 - 2. Description: Linear or switched, regulated power supplies with ac input to one or multiple dc output(s).
 - a. Include both line and load regulation to ensure stable output.

- b. To protect both power supply and load, include power supply with an automatic current limiting circuit.
- 3. Features:
 - a. Connection: Plug-in style suitable for mating with standard [8-pin octal]socket. Include power supply with mating mounting socket.
 - b. Housing: Enclose circuitry in a housing.
 - c. Local Adjustment: Include screw adjustment on exterior of housing for dc voltage output.
 - d. Mounting: DIN rail.
 - e. Visual status indicator.
 - f. <Insert feature>.
- 4. Performance:
 - a. Input Voltage: Nominally 120 V ac, 60 Hz.
 - b. Output Voltage: Nominally 24 V dc with plus or minus 1 V dc adjustment.
 - c. Output Current: Minimum 100 mA.
 - d. Load Regulation: Within 0.1 percent.
 - e. Line Regulation: Within 0.05 percent.
 - f. Stability: Within 0.1 percent of rated volts after warmup period.
 - g. Ripple: 1 mV rms.

2.33 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

- A. Furnish local UPS units, of type indicated, installed with DDC system.
- B. DIN Rail Mounted UPS:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APC by Schneider Electric.
 - b. Emerson Electric Co., Automation Solutions.
 - c. Phoenix Contact.
 - 2. Provide continuous, regulated output power without using batteries during brown-out, surge, and spike conditions.
 - 3. Performance:
 - a. Capacity: Load not to exceed 75 percent of rated capacity.
 - b. Efficiency: Minimum 94 percent.
 - c. Input Voltage: Single phase, 120 V ac, compatible with field power source.
 - d. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
 - e. Output Voltage: 101 to 132 V ac, while input voltage varies between 89 and 152 V ac.
 - f. On Battery Output Voltage: Sine wave.
 - g. Inverter Overload Capacity: Minimum 150 percent for 30 seconds.
 - h. Battery Backup: [Five] [10] [15] minutes of operation at full load with battery power.
 - i. Battery Recharge Time: Maximum of six hours to 90 percent capacity after full discharge.
 - j. Transfer Time: 6 ms.
 - k. Surge Voltage Withstand Capacity: IEEE C62.41.1 and IEEE C62.41.2, Categories A and B.
 - 4. Automatic bypass operation during fault or overload conditions.
 - 5. Integral line-interactive, power condition topology to eliminate all power contaminants.
 - 6. Include power switch and visual indication of power, battery, fault[, and temperature].

7. Include audible alarm of faults with silence feature.
 8. Include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure)[**and connect points to DDC system**].
 9. Batteries: Sealed; maintenance free; replacement without dropping load.
- C. Tower UPS Models through 1000 VA:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APC by Schneider Electric.
 - b. Eaton.
 - c. Toshiba International Corporation.
 2. Provide continuous, regulated output power without using batteries during brown-out, surge, and spike conditions.
 3. Performance:
 - a. Capacity: Load not to exceed 75 percent of rated capacity.
 - b. Efficiency: Complying with ENERGY STAR requirements; minimum 91 percent.
 - c. Input Voltage: Single phase, 120 V ac, compatible with field power source.
 - d. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
 - e. Output Voltage: 101 to 132 V ac, while input voltage varies between 89 and 152 V ac.
 - f. On Battery Output Voltage: Sine wave.
 - g. Inverter Overload Capacity: Minimum 150 percent for 30 seconds.
 - h. Battery Backup: **[Five] [10] [15] <Insert number>** minutes of operation at full load with battery power.
 - i. Battery Recharge Time: Maximum of six hours to 90 percent capacity after full discharge to cutoff.
 - j. Transfer Time: 0 ms.
 - k. Surge Voltage Withstand Capacity: IEEE C62.41.1 and IEEE C62.41.2, Categories A and B; 6 kV/200 and 500 A; 100 kHz ring wave.
 4. Automatic bypass operation during fault or overload conditions.
 5. Integral line-interactive, power condition topology to eliminate all power contaminants.
 6. Include power switch and visual indication of power, battery, fault, and temperature.
 7. Include audible alarm of faults and front panel silence feature.
 8. Receptacles: Minimum four, NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
 9. Remote Alarms: Include dry contacts (digital output points) or serial communication interface for low battery condition and battery-on (primary utility power failure) and connect points to DDC system.
 10. Batteries: Sealed type; maintenance free. Battery replacement is to be front accessible by user without dropping load.
 11. Install tower models in enclosures rated for location.
- D. UPS Models through 3000 VA: **[Tower] [and] [Rack]**.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APC by Schneider Electric.
 - b. Eaton.
 - c. Toshiba International Corporation.
 2. NRTL Listing: UL 1778.
 3. Provide continuous, regulated output power without using batteries during brown-out, surge, and spike conditions.

4. Performance:
 - a. Capacity: Load not to exceed 75 percent of UPS rated capacity.
 - b. Efficiency: Complying with ENERGY STAR requirements; minimum 91 percent.
 - c. Input Voltage: Single phase, 120 V ac, plus 20 to minus 30 percent.
 - d. Power Factor: Minimum 0.95 at full load.
 - e. Output Voltage: Single phase, 120 V ac, within 2 percent.
 - f. Inverter overload capacity to be minimum 150 percent for 30 seconds.
 - g. Battery Backup: **[Five] [10] [15]** minutes of operation at full load with battery power.
 - h. Battery Recharge Time: Maximum of 8 hours to 90 percent capacity.
 - i. Transfer Time: 0 ms.
 - j. **<Insert additional performance requirement>.**
5. LCD display with operator interface.
6. Receptacles: Minimum 6, NEMA WD 1, NEMA WD 6 Configuration 5-15R or 5-20R receptacles.
7. Automatic bypass operation during fault or overload conditions.
8. Remote Alarms: Include dry contacts (digital output points) or serial communication interface for low battery condition and battery-on (primary utility power failure) and connect points to DDC system.
9. Batteries: Sealed; maintenance free.
10. Enclosures: Install tower models in enclosures rated for location. Install rack models installed on matching racks, as applicable to particular installation location and space availability/configuration.

2.34 PRESSURE INSTRUMENT SIGNAL AIR PIPING AND TUBING

- A. Products in this article are intended for use with the following:
 1. Main air and signal air to pneumatically controlled instruments, actuators, and other control devices and accessories.
 2. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers, and accessories.
- B. Copper Tubing:
 1. Seamless phosphor deoxidized copper, drawn tempered, or soft annealed, with chemical and physical properties in accordance with ASTM B75/B75M.
 2. Performance, dimensions, weight, and tolerance in accordance with ASTM B280.
 3. Diameter, as required by application, not less than nominal 1/4 inch (6 mm).
 4. Wall thickness, as required by application, but not less than 0.030 inch (0.8 mm).
 5. Copper Tubing Connectors and Fittings - Brass, Compression Type:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BrassCraft Manufacturing Co.; a Masco company.
 - 2) DK-LOK USA.
 - 3) Mid-America Fittings; a Midland Industries Company.
 - 4) Parker Hannifin Corporation.
 - b. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.

6. Copper Tubing Connectors and Fittings - Copper, Solder-Joint Type:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems.
 - 2) NIBCO INC.
 - 3) Paul Mueller Company.
 - b. Copper Solder-Joint Fittings: Cast, ASME B16.18 or wrought, ASME B16.22.
 - C. Galvanized-Steel Piping (for Pneumatic/Pressure Instrument Signal Air):
 1. Pipe: ASTM A53/A53M, Schedule 40.
 2. Fittings: Galvanized malleable iron, ASME B16.3, Class 150.
 - D. Polyethylene Tubing: (~~For Pneumatic~~/Pressure Instrument Signal Air).
 1. Fire-resistant, black virgin polyethylene in accordance with ASTM D1248, Type 1, Class C, and Grade 5.
 2. Complying with stress crack test in accordance with ASTM D1693.
 3. Diameter, as required by application, of not less than nominal 1/4 inch (6 mm).
 4. Polyethylene Tubing Connectors and Fittings - Brass, Barb Fittings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BrassCraft Manufacturing Co.; a Masco company.
 - 2) DK-LOK USA.
 - 3) Mid-America Fittings; a Midland Industries Company.
 - 4) Parker Hannifin Corporation.
 - b. Tapered and beaded hose barbs of push-on design; intended for low-pressure applications only.
 5. Polyethylene Tubing Connectors and Fittings - Brass, Compression Type:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BrassCraft Manufacturing Co.; a Masco company.
 - 2) DK-LOK USA.
 - 3) Mid-America Fittings; a Midland Industries Company.
 - 4) Parker Hannifin Corporation.
 - b. Specially designed for jointing polyethylene tubing to provide leak-free seal without twisting or weakening polyethylene tubing.
- 2.35 PROCESS TUBING
- A. Products in this article are intended for signals to instruments connected to liquid and steam systems.
 - B. Copper Tubing:
 1. Seamless phosphor deoxidized copper, drawn tempered with chemical and physical properties in accordance with ASTM B75/B75M.
 2. Performance, dimensions, weight, and tolerance in accordance with ASTM B280.
 3. Diameter, as required by application, of not less than nominal 3/8 inch (10 mm).
 4. Wall thickness, as required by application, but not less than 0.030 inch (0.8 mm).

5. Copper Tubing Connectors and Fittings (for Process Tubing) - Brass, Compression Type:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BrassCraft Manufacturing Co.; a Masco company.
 - 2) DK-LOK USA.
 - 3) Mid-America Fittings; a Midland Industries Company.
 - 4) Parker Hannifin Corporation.
 - b. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.
 6. Copper Tubing Connectors and Fittings (for Process Tubing) - Brass, Solder-Joint Type:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems.
 - 2) NIBCO INC.
 - b. Copper Solder-Joint Fittings: Cast, ASME B16.18 or wrought, ASME B16.22.
 - C. Stainless Steel Tubing (for Process Tubing):
 1. Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, and free from scale.
 2. Chemical and physical properties in accordance with ASTM A269/A269M.
 3. Diameter, as required by application, of not less than nominal 3/8 inch (10 mm).
 4. Wall thickness, as required by application, but not less than 0.035 inch (0.9 mm).
 5. Furnish stainless steel tubing in 20 ft. (6 m) straight random lengths.
 - D. Stainless Steel Tubing Connectors and Fittings (for Process Tubing) - Stainless Steel, Compression Type:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. DK-LOK USA.
 - b. Parker Hannifin Corporation.
 - c. Sizto Tech Corporation (STC).
 2. Connectors and fittings constructed from Type 316 stainless steel, with collets, flareless type.
 3. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.
 4. Connect instruments to tubing with connectors having compression connector on one end and IPS or NPT thread on other end.
- 2.36 CONTROL WIRE AND CABLE
- A. Wire: Single conductor control wiring above 24 V.
 1. Wire Size: Minimum **[18]** **[16]** **[14]** AWG.
 2. Conductors: 7/24 soft annealed copper strand with 2- to 2.5-inch (50- to 65-mm) lay.
 3. Conductor Insulation: 600 V, Type THWN or Type THHN, and 90 deg C in accordance with UL 83.
 4. Conductor Insulation Colors: Black (hot), white (neutral), and green (ground).
 5. Furnish on spools.

- B. Single, Twisted-Shielded, Instrumentation Cable above 24 V:
 - 1. Wire Size: Minimum [18] [20] [22] AWG.
 - 2. Conductors: Twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch (50- to 65-mm) lay.
 - 3. Conductor Insulation: Type THHN/THWN or Type TFN rating.
 - 4. Conductor Insulation Colors:
 - a. Twisted Pair: Black and white.
 - b. Twisted Triad: Black, red, and white.
 - 5. Shielding: 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 - 6. Outer Jacket Insulation: 600 V, 90 deg C rating, and Type TC cable.
 - 7. Furnish on spools.
- C. Single, Twisted-Shielded, Instrumentation Cable 24 V and Less:
 - 1. Wire Size: Minimum [18] [20] [22] AWG.
 - 2. Conductors: Twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch (50- to 65-mm) lay.
 - 3. Conductor Insulation: Nominal 15-mil thickness, constructed from flame-retardant PVC.
 - 4. Conductor Insulation Colors:
 - a. Twisted Pair: Black and white.
 - b. Twisted Triad: Black, red, and white.
 - 5. Shielding: 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 - 6. Outer Jacket Insulation: 300 V, 105 deg C rating, and Type PLTC cable.
 - 7. Furnish on spools.
- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
 - 1. Comply with following requirements for balanced twisted pair cable described in [Section 260523 "Control-Voltage Electrical Power Cables."] [Section 271513 "Communications Copper Horizontal Cabling."]
 - a. Plenum rated.
 - b. Unique color that is different from other cables used on Project.

2.37 RACEWAYS

- A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems" for electrical power raceways and boxes.
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cables and optical fiber cables.

2.38 OPTICAL FIBER CABLE AND CONNECTORS

- A. Comply with requirements in Section 271323 "Communications Optical Fiber Backbone Cabling" for optical fiber backbone cabling and connectors.
- B. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical fiber horizontal cabling and connectors.

2.39 ACCESSORIES

A. Pneumatic Pressure Gauges:

1. Face Size: 1.5-inch- (38-mm-) diameter face for pressures up through 30 psig (207 kPa) and 2.5-inch- (65-mm-) diameter face for greater pressures.
2. Face Markings: White dial face with black printing; 1 psig (6.9 kPa) increment for scale ranges through 30 psig (207 kPa) and 2 psig (13.8 kPa) increment for larger ranges.
3. Accuracy: Within 1 percent of full-scale range.
4. Applications: Include separate gauges for branch pressure and main pressure tubing.

B. Pressure Electric Switches:

1. Description: Diaphragm-operated, snap-acting switch.
2. Performance:
 - a. Rating: Resistance loads at 120 V ac.
 - b. Set Point: Adjustable from 3 to 20 psig (21 to 138 kPa).
 - c. Differential: Adjustable from 2 to 6 psig (14 to 41 kPa).
3. Body and Switch Housing: Metal.

C. Control Damper Blade Limit Switches:

1. Application: Sense positive open and/or closed position of damper blades.
2. NEMA 250, Type 13, oiltight construction. Install in instrument enclosure where required for additional environmental protection.
3. Arrange for mounting application, and to prevent "over-center" operation.

D. I/P and E/P Transducers:

1. Commercial Grade:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) ControlAir, Inc.
 - 2) Dwyer Instruments, Inc.
 - 3) KMC Controls, Inc.
 - 4) MAMAC Systems, Inc.
 - b. Description: Transducer converting an electronic current (I) or voltage (E) AO signal to a proportional or stepped pneumatic signal. Unless otherwise required by operating sequence, use 3 to 15 psig (21 to 103 kPa) pneumatic signal for pneumatic actuation.
 - c. Features:
 - 1) Auto/manual output switch, manual output control, and output pressure gauge.
 - 2) Separate zero and span calibration adjustments.
 - d. Performance:
 - 1) Accuracy: Within 1.0 percent of output span.
 - 2) Linearity: Within 1.0 percent of output span.
 - 3) Output Capacity: Not less than 550 scim (0.54 cu. m/h) at 15 psig (103 kPa).
 - 4) Maximum Pressure: **[30 psig (206 kPa)] [40 psig (276 kPa)]** of supply pressure without damage.
 - 5) Vibration: Construct entire assembly so that shock and vibration will not harm transducer or affect accuracy.

- e. Applications:
 - 1) Terminal Units: Fan-coil units, VAV units, unit heaters, and **<Insert equipment>**.
 - 2) **<Insert applications>**.
- 2. Industrial Grade:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) ControlAir, Inc.
 - 2) Fischer; Emerson Electric Co., Automation Solutions.
 - 3) Marsh Bellofram.
 - b. Description: Transducer converting an electronic current (I) or voltage (E) AO signal to a proportional pneumatic signal (P). Unless otherwise required by operating sequence, use 3 to 15 psig (21 to 103 kPa) pneumatic signal for pneumatic actuation. Stepped pneumatic signal is unacceptable.
 - c. Features:
 - 1) Adjustments: Separate zero and span calibration adjustments.
 - 2) Conduit Connections: Nominal 1/2 inch (13 mm).
 - 3) Enclosure: NEMA 250, Type 4X.
 - 4) Pressure Gauge: Integral output pressure gauge.
 - d. Performance:
 - 1) Accuracy: Within 1.0 percent of output span.
 - 2) Hysteresis: Within 0.5 percent of output span.
 - 3) Linearity: Within 0.75 percent of output span.
 - 4) Repeatability: Within 0.5 percent of output span.
 - 5) Output Capacity: Not less than 5 scfm at 15 psig (103 kPa).
 - 6) Air Consumption: Maximum of 5 scfh at 15 psig (103 kPa).
 - 7) Ambient Temperature: Suitable for operation in ambient temperature range of minus 20 to 150 deg F (minus 40 to 66 deg C).
 - 8) Pressure: Up to 50 psig (345 kPa) without damage.
 - 9) Vibration: Construct entire assembly so shock and vibration will not harm transducer or affect accuracy.
 - e. Applications:
 - 1) All applications, except for terminal units and other applications with commercial-grade transducers.
 - 2) **<Insert applications>**.
- E. E/P Switch:
 - 1. Body: Cast aluminum or brass; three pipe body (common, normally open, and normally closed).
 - 2. Internal Components: Brass, copper, steel, or stainless steel.
 - 3. Connections: Barb or threaded for mating to compression fittings.
 - 4. Rating: 30 psig (207 kPa) when installed in systems below 25 psig (172 kPa); 150 psig (1034 kPa) when installed in systems above 25 psig (172 kPa).
 - 5. Features: Include coil transient suppression.

F. Instrument Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Mfg. Co. Inc.
 - b. Hoffman; brand of nVent Electrical plc.
 - c. Saginaw Control and Engineering.
2. Application: Include instrument enclosure for secondary protection to comply with requirements indicated in "Performance Requirements" Article.
3. Certification: NRTL listed and labeled to UL 50 or UL 508A as applicable.
4. Subpanel:
 - a. Size enclosure with least 25 percent spare area on subpanel.
 - b. Mount instrument(s) within enclosure on internal subpanel(s).
5. Identification: Include on face of enclosure an engraved, laminated phenolic nameplate for each instrument installed within enclosure.
6. Pneumatic Pressure Gauges: Include main pressure gauge and a branch pressure gauge for each pneumatic device installed inside enclosure.
7. Raceways: For enclosures housing multiple instruments, route tubing, cable, and wiring within enclosure in a raceway having continuous removable cover.
8. Access: Provide enclosures larger than 12 inches (300 mm) with hinged full-size face cover.
9. Security: Equip enclosures with lock and common key.

G. Manual Valves:

1. Brass Needle Valves:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BrassCraft Manufacturing Co.; a Masco company.
 - 2) Parker Hannifin Corporation.
 - b. Pressure Rating: 150 psig (1030 kPa).
 - c. Temperature Rating: 250 deg F (121 deg C).
 - d. Body: Brass.
 - e. Seat: Brass.
 - f. Handle: Aluminum, brass, or stainless steel T-bar handle.
 - g. Connections: Include tubing connections.
 - h. Applications: Copper and polyethylene pneumatic tubing.
2. Stainless Steel Needle Valves:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) DK-LOK USA.
 - 2) Parker Hannifin Corporation.
 - 3) Sizto Tech Corporation (STC).
 - b. Pressure Rating: 5000 psig (34 474 kPa).
 - c. Temperature Rating: 450 deg F (232 deg C).
 - d. Body: Type 316 stainless steel.
 - e. Seat: Type 316 stainless steel.
 - f. Packing: PTFE.
 - g. Handle: Aluminum or stainless steel T-bar handle.

- h. Connections: Include tubing connections.
 - i. Applications: Copper pneumatic tubing; copper and stainless steel process tubing.
- 3. Bronze Body Ball Valves:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - 2) Milwaukee Valve Company.
 - 3) NIBCO INC.
 - b. Standard: MSS SP-110.
 - c. SWP Rating: 150 psig (1035 kPa).
 - d. CWP Rating: 600 psig (4140 kPa).
 - e. Body Design: Two piece.
 - f. Body Material: Bronze.
 - g. Ends: Threaded.
 - h. Seats: PTFE.
 - i. Stem: Stainless steel.
 - j. Ball: Stainless steel, vented.
 - k. Handle: Stainless steel with vinyl grip.
 - l. Port: Full.

H. Retractable, Wall-Mounted Cabinet for Portable Workstations:

- 1. Description: Surface-mounted or recessed wall cabinet for tilt-out operation of laptop computers and large-format mobile devices.
- 2. Cabinet Load Limit: 50 lb (23 kg).
- 3. Cabinet Material: Carbon steel.
- 4. Cabinet Finish: Powder-coat epoxy; manufacturer's standard color.
- 5. Features include the following:
 - a. Oil-filled dampers for controlled lowering of equipment to operational position.
 - b. 3RU EIA mounting rails.
 - c. Removable laptop shelf.
 - d. Separate top compartment with mounting area, hinged rail.
 - e. Front ventilation slots.
 - f. Security key lock access.
 - g. Knockouts for conduit connections on top and bottom of cabinet.
 - h. **<Insert additional features>.**
- 6. Field Coordination: Provide inside center of backbox with provision to mount a field-furnished and -installed, single-gang electrical outlet box.

2.40 IDENTIFICATION

A. Instrument Air Pipe and Tubing:

- 1. Engraved tag bearing the following information:
 - a. Service (Example): "Instrument Air."
 - b. Pressure Range (Example): 0 to 30 psig (0 to 200 kPa).
- 2. Letter size minimum of 0.25 inch (6 mm) high.
- 3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded blue with contrasting white center exposed by engraving through outer layer.
- 4. Include tag with brass grommet, chain, and S-hook.

B. Control Equipment, Instruments, and Control Devices:

1. Laminated acrylic or melamine plastic sign bearing unique identification.
 - a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
2. Letter size as follows:
 - a. Servers: Minimum of 0.5 inch (13 mm) high.
 - b. DDC Controllers: Minimum of 0.5 inch (13 mm) high.
 - c. Gateways: Minimum of 0.5 inch (13 mm) high.
 - d. Repeaters: Minimum of 0.5 inch (13 mm) high.
 - e. Enclosures: Minimum of 0.5 inch (13 mm) high.
 - f. Electrical Power Devices: Minimum of 0.25 inch (6 mm) high.
 - g. UPS units: Minimum of 0.5 inch (13 mm) high.
 - h. Accessories: Minimum of 0.25 inch (6 mm) high.
 - i. Instruments: Minimum of 0.25 inch (6 mm) high.
 - j. Control Damper and Valve Actuators: Minimum of 0.25 inch (6 mm) high.
3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded black with contrasting white center exposed by engraving through outer layer.
4. Fastened with drive pins.
5. Instruments, control devices, and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

C. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tag Size: Minimum 1.5 inches (38 mm) in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

D. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as tape banding for conduits. After painting, label cover plate "HVAC Controls".
3. For raceways housing pneumatic tubing, add phenolic tag labeled "HVAC Instrument Air Tubing."
4. For raceways housing air signal tubing, add phenolic tag labeled "HVAC Air Signal Tubing."

E. Equipment Warning Labels:

1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size at least 14-point type with white lettering on red background.
3. Warning label to read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering to be enclosed in a white line border. Edge of label is to extend at least 0.25 inch (6 mm) beyond white border.

2.41 SOURCE QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to evaluate the following in accordance with industry standards for each product, and to verify DDC system reliability specified in performance requirements:
 - 1. DDC controllers.
 - 2. Gateways.
 - 3. Routers.
 - 4. **<Insert product>**.
- B. Product(s) **[and] [material(s)]** will be considered defective if **[it does] [they do]** not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

- A. Communication Interface to Equipment with Integral Controls:
 - 1. DDC system has communication interface with equipment having integral controls and having communication interface for remote monitoring or control.
- B. Communication Interface to Other Building Systems:
 - 1. DDC system communicates with systems having communication interface.
 - 2. Systems to Be Connected:
 - a. Elevators specified in Section 142100 "Electric Traction Elevators."
 - b. Elevators specified in Section 142113 "Electric Traction Freight Elevators."
 - c. Elevators specified in Section 142400 "Hydraulic Elevators."
 - d. Elevators specified in Section 142413 "Hydraulic Freight Elevators."
 - e. Escalators specified in Section 143100 "Escalators."
 - f. Automated water treatment systems specified in Section 232500 "HVAC Water Treatment."
 - g. Automated water treatment systems specified in Section 232516 "Water Treatment for Open-Loop Hydronic Systems."
 - h. Automated water treatment systems specified in Section 232519 "Water Treatment for Steam System Feedwater."

- i. Power monitoring specified in Section 260913 "Electrical Power Monitoring."
- j. Lighting controls specified in Section 260936 "Modular Dimming Controls."
- k. Lighting controls specified in Section 260943.16 "Addressable Luminaire Lighting Controls."
- l. Lighting controls specified in Section 260943.23 "Relay-Based Lighting Controls."
- m. Fire-alarm system specified in Section 284621.11 "Addressable Fire-Alarm Systems."
- n. Fire-alarm system specified in Section 284621.13 "Conventional Fire-Alarm Systems."
- o. Access controls specified in Section 281300 "Access Control System Software and Database Management."
- p. Intrusion detection specified in Section 283100 "Intrusion Detection."
- q. Perimeter security specified in Section 283121 "Area and Perimeter Intrusion Detection."
- r. **<Insert system and Section number and title>.**

3.3 PREINSTALLATION INTEGRATION TESTING

- A. Perform the following pretesting of other systems and equipment integration with DDC system before field installation:
 - 1. Test all communications in a controlled environment to ensure connectivity.
 - 2. Load software and demonstrate functional compliance with each control sequence of operation indicated.
 - 3. Using simulation, demonstrate compliance with sequences of operation and other requirements indicated including, but not limited to, the following:
 - a. HVAC equipment controlled through DDC system, such as boilers, chillers, pumps, and air-handling units.
 - b. Equipment faults and system recovery with fault annunciation.
 - c. Analog and Boolean value alarming and annunciation.
 - 4. Develop a method for testing interfaces before deployment.
 - 5. Submit documentation supporting compliance upon request.

3.4 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

- A. Interface with Existing Systems:
 - 1. Interface DDC systems with existing systems to achieve integration indicated.
 - 2. Monitoring and Control of DDC System by Existing Control System:
 - a. Satisfy DDC system performance requirements when monitoring and controlling DDC system by existing control system.
 - b. Operator of existing system to upload, download, monitor, trend, control, and program every I/O point in DDC system from existing control system using existing control system software and operator workstations.
 - c. Make interface so operator of existing system is not required to learn new software for remote monitoring and control from existing control system.
 - d. Make interface of DDC system into existing control system transparent to operators of existing control system and allow operators to **[program, monitor, and control] [monitor and control]** DDC system from any operator workstation connected to existing control system.
 - e. **<Insert requirements>.**

3. Integration of Existing Control System into DDC System:
 - a. Satisfy existing control system performance requirements when monitoring and controlling existing control system through DDC system.
 - b. Operator to upload, download, monitor, alarm, report, trend, control, and program every I/O point in existing system from DDC system using operator workstations and software provided. Combined systems to share one database.
 - c. Make interface of existing control system I/O points into DDC system transparent to operators. Make all operational capabilities identical regardless of whether I/O already exists, or I/O is being installed.
 - d. **<Insert requirements>**.
- B. Integration with Existing Enterprise System:
 1. Interface DDC system with an existing enterprise system to adhere to Owner standards already in-place and to achieve integration.
 2. Owner's control system integrator to provide the following services:
 - a. Enterprise system expansion and development of graphics, logs, reports, trends, and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
 - b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
 - c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.
 3. Engage Owner's control system integrator to provide the following services:
 - a. Enterprise system expansion and development of graphics, logs, reports, trends, and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
 - b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
 - c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.
 4. Control System Integrator Contact Information:
 - a. Company: **<Insert name>**.
 - b. Company Street Address: **<Insert address>**.
 - c. Company Contact: **<Insert name>**.
 - d. Phone Number: **<Insert phone number>**.
 - e. Email Address: **<Insert email address>**.
 5. Attend meetings with control system integrator to integrate DDC system.
- 3.5 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS
 - A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
 - B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
 1. Control dampers, which are specified in Section 230923.12 "Control Dampers."
 2. Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."
 3. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."

4. **<Insert additional control devices>.**
- C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.
1. Control valves, which are specified in Section 230923.11 "Control Valves."
 2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."
 3. Pipe-mounted sensors, switches, and transmitters. Flow meters are specified in Section 230923.14 "Flow Instruments."
 4. Tank-mounted sensors, switches, and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
 5. Liquid[**and steam**] temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
 6. Pipe- and tank-mounted thermowells. Liquid[**and steam**] thermowells are specified in Section 230923.27 "Temperature Instruments."
 7. **<Insert additional control devices>.**
- 3.6 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION
- A. Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer[**and supervise installation for compliance with requirements**].
1. **[Programmable application] [or] [application-specific]** controller.
 2. Unit-mounted DDC control dampers and actuators, which are specified in Section 230923.12 "Control Dampers."
 3. Unit-mounted airflow sensors, switches, and transmitters, which are specified in Section 230923.14 "Flow Instruments."
 4. Unit-mounted gas sensors, and transmitters, which are specified in Section 230923.16 "Gas Instruments."
 5. Unit-mounted leak-detection switches, which are specified in Section 230923.18 "Leak Detection Instruments."
 6. Unit-mounted pressure sensors, switches, and transmitters, which are specified in Section 230923.23 "Pressure Instruments."
 7. Unit-mounted speed sensors, switches, and transmitters, which are specified in Section 230923.24 "Speed Instruments."
 8. Unit-mounted temperature sensors, switches, and transmitters. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
 9. Relays.
 10. **<Insert additional control devices>.**
- B. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.
1. **[Programmable application] [or] [application-specific]** controller.
 2. Electric damper actuator. Damper actuators are specified in Section 230923.12 "Control Dampers."
 3. Unit-mounted flow and pressure sensors, transmitters, and transducers. Flow sensors, transmitters, and transducers are specified in Section 230923.14 "Flow Instruments." Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
 4. Unit-mounted temperature sensors. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
 5. Relays.
 6. **<Insert additional control devices>.**

- C. Deliver the following to fan-coil unit manufacturer for factory installation. Include installation instructions to fan-coil unit manufacturer.
 - 1. **[Programmable application] [or] [application-specific]** controller.
 - 2. Unit-mounted temperature sensors. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
 - 3. Flow and pressure switches. Air and liquid flow sensors, transmitters, and transducers are specified in Section 230923.14 "Flow Instruments." Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
 - 4. Leak-detection switches, which are specified in Section 230923.18 "Leak Detection Instruments."
 - 5. Relays.
 - 6. **<Insert control devices>**.

3.7 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring, and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to **<Insert value>** force.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."
- H. Welding Requirements:
 - 1. Restrict welding and burning to supports and bracing.
 - 2. No equipment is cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
 - 3. Welding, where approved, is to be by inert-gas electric arc process and is to be performed by qualified welders in accordance with applicable welding codes.
 - 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
 - 1. Wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

K. Corrosive Environments:

1. Avoid or limit use of materials in corrosive airstreams and environments including, but not limited to, the following:
 - a. Laboratory exhaust-air streams.
 - b. Process exhaust-air streams.
 - c. **<Insert conditions>**.
2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not already corrosive resistant from instrument manufacturer, field install products in NEMA 250, Type 4X instrument enclosure constructed of Type 316L stainless steel.

3.8 INSTALLATION OF WORKSTATIONS

A. Desktop Workstation Installation:

1. Install **[Owner-furnished]** workstation(s) at location(s) indicated on Drawings.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex, electrical power receptacle.
3. Install DDC system software on workstation(s) and verify that software functions properly.
4. Develop Project-specific graphics, trends, reports, logs, and historical database.
5. Power **[each]** workstation through a **[dedicated]** UPS unit. Locate UPS adjacent to workstation.

B. Portable Workstation Installation:

1. Install DDC system software on **[Owner-furnished]** workstation(s) and verify that software functions properly.

C. Color Graphics Application:

1. Use system schematics indicated on Drawings as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's **[and Architect's]** review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Make final editing on-site with Owner's **[and Architect's]** review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

D. Retractable, Wall-Mounted Cabinet for Portable Operator's Workstation Installation:

1. Install retractable, wall-mounted portable operator's workstation cabinet(s) at location(s) indicated on Drawings.
2. Install retractable, wall-mounted portable operator's workstation cabinet(s) at following location(s) and at additional locations indicated on Drawings:
 - a. Each mechanical room.

- b. Chiller room.
 - c. Boiler room.
 - d. <Insert location>.
 - 3. Connect each cabinet to 120 V, single-phase, 60 Hz field power source and install single gang electrical box with NEMA WD 6, Type 20R duplex receptacle and metal cover plate in cabinet. Comply with requirements in Section 262726 "Wiring Devices."
 - 4. Connect each cabinet to Ethernet network and install an Ethernet network port for connection to portable operator workstation Ethernet cable. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."
- 3.9 INSTALLATION OF POT
- A. Install **[one]** **[two]** POT(s).
 - B. Turn over POTs to Owner at Substantial Completion.
 - C. Install software on each POT and verify that software functions properly.
- 3.10 INSTALLATION OF SERVERS
- A. Install server(s) at location(s) indicated on Drawings.
 - B. Install number of servers required to suit requirements indicated. Review Project requirements and indicate layout of proposed server location in Shop Drawings.
 - C. Install software indicated on server(s) and verify that software functions properly.
 - D. Develop Project-specific graphics, trends, reports, logs, and historical database.
 - E. Power servers through **[dedicated]** UPS unit. Locate UPS adjacent to server. Install rack-mounted UPS units for powering rack-mounted servers and tower UPS units for tower servers.
- 3.11 INSTALLATION OF PRINTERS
- A. Install **[Owner-furnished]** printers at location(s) indicated on Drawings.
 - B. Install applicable printer software on **[Owner-furnished]** workstations and verify that software functions properly.
- 3.12 INSTALLATION OF GATEWAYS
- A. Install gateways if required for DDC system communication interface requirements indicated.
 - 1. Install gateway(s) required to suit indicated requirements.
 - a. <Insert requirements>.
 - B. Test gateways to verify that communication interface functions properly.
- 3.13 INSTALLATION OF ROUTERS
- A. Install routers if required for DDC system communication interface requirements indicated.
 - 1. Install router(s) required to suit indicated requirements.
 - a. <Insert requirements>.
 - B. Test routers to verify that communication interface functions properly.
- 3.14 INSTALLATION OF CONTROLLERS
- A. Install controllers in enclosures to comply with indicated requirements.

- B. Connect controllers to field power supply[**and to UPS units where indicated**].
- C. Install controllers with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Installation of Network Controllers:
 - 1. DDC system provider and DDC system manufacturer to determine quantity and location of network controllers to satisfy requirements indicated. [**Provide minimum quantity indicated.**]
 - 2. Install controllers in a protected location that is easily accessible by operators.
 - 3. Locate top of controller within 72 inches (1800 mm) of finished floor.
- F. Installation of Programmable Application Controllers:
 - 1. DDC system provider and DDC system manufacturer to determine quantity and location of programmable application controllers to satisfy requirements indicated. [**Provide minimum quantity indicated.**]
 - 2. Install controllers in a protected location that is easily accessible by operators.
 - 3. Locate top of controller within 84 inches (2100 mm) of finished floor, except where dedicated controllers are installed at terminal units.
- G. Application-Specific Controllers:
 - 1. DDC system provider and DDC system manufacturer to determine quantity and location of application-specific controllers to satisfy requirements indicated. [**Provide minimum quantity indicated.**]
 - 2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.15 INSTALLATION OF WIRELESS ROUTERS FOR OPERATOR INTERFACE

- A. Install wireless routers to achieve optimum performance and best possible coverage.
- B. Mount wireless routers in a protected location that is within 60 inches (1500 mm) of floor and easily accessible by operators.
- C. Connect wireless routers to field power supply and to UPS units if network controllers are powered through UPS units.
- D. Install wireless router with latest version of applicable software and configure wireless router with security and password protection. Create access password with not less than 12 characters consisting of letters and numbers and at least one special character. Document password in operations and maintenance manuals for reference by operators.
- E. Test and adjust wireless routers for proper operation with all types (such as, laptops, smartphones, and tablets) of wireless devices intended for use by operators.

3.16 INSTALLATION OF ENCLOSURES

- A. Install the following items in enclosures, to comply with indicated requirements:
 - 1. Gateways.
 - 2. Routers.
 - 3. Controllers.
 - 4. Electrical power devices.
 - 5. UPS units.
 - 6. Relays.

7. Accessories.
8. Instruments.
9. Actuators.
10. **<Insert devices>**.

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250, Type 1 Enclosures: Use **[painted steel] [galvanized-steel] [corrosion-resistant-coated steel]** strut and hardware.
2. For NEMA 250, Type 4 Enclosures and Enclosures Located Outdoors: Use stainless steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align top or bottom of adjacent enclosures.

D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using galvanized-steel or stainless steel anchors.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireways used for application are to have protection equal to NEMA 250 rating of connected enclosures.

3.17 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade to provide a fully functioning DDC system. Work is to comply with NFPA 70, and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems" for electrical power raceways and boxes.

3.18 INSTALLATION OF IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

B. Install laminated acrylic or melamine plastic signs with unique identification on face for each of the following:

1. Server.
2. Gateway.
3. Router.
4. Protocol analyzer.
5. DDC controller.
6. Enclosure.
7. Electrical power device.
8. UPS unit.
9. Accessory.

C. Install unique instrument identification for each instrument connected to DDC controller.

- D. Install unique identification for each control damper and valve actuator connected to DDC controller.
- E. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.
- F. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.
- G. Warning Labels and Signs:
 - 1. Permanently attach to equipment that can be automatically started by DDC control system.
 - 2. Locate where highly visible near power service entry points.

3.19 INSTALLATION OF NETWORKS

- A. Install optical fiber cable when connecting between the following network devices and when located in different buildings on campus, or when distance between devices exceeds **<Insert distance>**:
 - 1. Operator workstations.
 - 2. Operator workstations and network controllers.
 - 3. Network controllers.
 - 4. **<Insert network device>**.
- B. Install balanced twisted pair [**or optical fiber**] cable when connecting between the following network devices[**located in same building**]:
 - 1. Operator workstations.
 - 2. Operator workstations and network controllers.
 - 3. Network controllers.
 - 4. **<Insert network device>**.
- C. Install balanced twisted pair or copper cable (as required by equipment) when connecting between the following:
 - 1. Gateways.
 - 2. Gateways and network controllers or programmable application controllers.
 - 3. Routers.
 - 4. Routers and network controllers or programmable application controllers.
 - 5. Network controllers and programmable application controllers.
 - 6. Programmable application controllers.
 - 7. Programmable application controllers and application-specific controllers.
 - 8. Application-specific controllers.
 - 9. **<Insert network device>**.
- D. Install cable in continuous raceway.
 - 1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

3.20 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

B. ASHRAE 135 Networks:

1. MAC Address:
 - a. Assign and document a MAC address unique to its network for every network device.
 - b. Ethernet Networks: Document MAC address assigned at its creation.
 - c. MS/TP Networks: Assign from 00 to 64.
2. Network Numbering:
 - a. Assign unique numbers to each new network.
 - b. Provide ability for changing network number through device switches or operator interface.
 - c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.
3. Device Object Identifier Property Number:
 - a. Assign unique device object identifier property numbers or device instances for each device network.
 - b. Provide for future modification of device instance number by device switches or operator interface.
 - c. LAN is to support up to 4,194,302 unique devices.
4. Device Object Name Property Text:
 - a. Device object name property field to support 32 minimum printable characters.
 - b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.
 - 1) Example 1: Device object name for device controlling heating water boiler plant at Building 1000 would be "Heating Water System Bldg. 1000."
 - 2) Example 2: Device object name for VAV terminal unit controller could be "VAV Unit 102."
5. Object Name Property Text for Other Than Device Objects:
 - a. Object name property field is to support 32 minimum printable characters.
 - b. Assign object name properties with plain-English names descriptive of application.
 - 1) Example 1: "Zone 1 Temperature."
 - 2) Example 2 "Fan Start and Stop."
6. Object Identifier Property Number for Other Than Device Objects:
 - a. Assign object identifier property numbers according to **[Drawings]** **[or]** **[tables]** indicated.
 - b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented, and be unique for like object types within device.

3.21 INSTALLATION OF AIR SIGNAL PIPING AND TUBING

A. Above-Grade Air Signal Piping and Tubing Installation:

1. Material Application:
 - a. Install copper tubing, except as follows:
 - 1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing.

- 2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when **[concealed behind accessible ceilings] [and] [concealed in walls and connecting wall-mounted instruments with recessed connections]**.
 - b. Install copper tubing for sizes up through NTS 1 (DN 25) and install galvanized-steel pipe for larger sizes, except as follows:
 - 1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing where exposed to view.
 - 2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when **[concealed behind accessible ceilings] [and] [concealed in walls and connecting wall-mounted instruments with recessed connections]**.
 - c. Pneumatic Tubing: Install copper tubing[, **unless other accessible materials are indicated,**] for pneumatic main and control signals to instruments including, but not limited to, the following:
 - 1) Pneumatic actuators.
 - 2) I/P transducers.
 - 3) Sensors.
 - 4) Switches.
 - 5) Transmitters.
 - 6) **<Insert instrument>**.
 - d. Install copper tubing[, **unless other accessible materials are indicated,**] for air signals to instruments including, but not limited to, the following:
 - 1) Sensors.
 - 2) Switches.
 - 3) Transmitters.
 - 4) **<Insert instrument>**.
 - e. Install drawn-temper copper tubing, except within 36 inches (900 mm) of device terminations tubing is to be annealed-tempered copper tubing.
 - f. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
 - g. Install **[barbed] [or] [compression]** fittings to connect polyethylene tubing to instruments, control devices, and accessories.
2. Routing:
- a. Do not expose tubing in finished spaces, such as spaces with ceilings; occupied spaces, offices, and conference rooms, unless expressly approved in writing by Architect. Tubing may be exposed in areas without ceilings.
 - b. Where tubing is installed in finished occupied spaces, install the tubing in surface metal raceway with appropriate fittings only where not feasible to conceal in wall, above ceiling, or behind architectural enclosures or covers.
 - c. Install piping and tubing plumb and parallel to and at right angles with building construction.
 - d. Install multiple runs of tubing or piping in equally spaced parallel lines.
 - e. Install piping and tubing not to interfere with access to valves, equipment, duct, and equipment access doors, or obstruct personnel access and passageways of any kind.
 - f. Coordinate with other trades before installation to prevent proposed piping and tubing from interfering with pipe, duct, terminal equipment, light fixtures, conduit, and cable tray space. If changes to Shop Drawings are necessary due to field coordination, document changes on Record Drawings.

- g. Install vibration loops in copper tubing when connecting to instruments and actuators that vibrate.
 - 3. Support:
 - a. Space supports in accordance with MSS SP-58, except support spacing not to exceed 60 inches (1500 mm).
 - b. Support copper tubing with copper hangers, clips, and tube trays.
 - c. Do not use tape for support or dielectric isolation.
 - d. Install supports at each change in direction and at each branch take-off.
 - e. Attached supports to building structure independent of work of other trades. Support from ducts, pipes, cable trays, and conduits is prohibited.
 - f. Attached support from building structure with threaded rods, structural shapes, or channel strut.
 - g. Install and brace supports to carry static load plus a safety margin, which will allow tubing to be serviced.
 - h. Brace supports to prevent lateral movement.
 - i. Paint steel support members that are not galvanized or zinc coated.
 - j. Support polyethylene tubing same as copper tubing.
 - 4. Do not attach piping and tubing to equipment that may be removed frequently for maintenance or that may impart vibration and expansion from temperature change.
 - 5. Protect exposed tubing in mechanical equipment rooms **[and similar utility spaces]** from mechanical damage within 96 inches (2400 mm) above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.
 - 6. Joining and Makeup:
 - a. Where joining and mating dissimilar metals where galvanic action could occur, install dielectric isolation.
 - b. Install dirt leg with an isolation valve and threaded plug at each main air, connection to panel, pneumatic pilot positioner, and PRV station.
 - c. Make threaded joints for connecting to instrument equipment with connectors with a compression tubing connector on one end and threaded connection on the other end.
 - d. Make tubing bends with tube-bending tool. Hard-bends or wrinkled or flattened bends are unacceptable.
 - e. Install tube fittings in accordance with manufacturer's written instructions.
 - f. Do not make tubing connections to a fitting before completing makeup of the connection.
 - g. Align tubing with fitting. Avoid springing tube into position; this may result in excessive stress on both tubing and fitting with possible resulting leaks.
 - h. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for proper connection.
 - i. Check tubing for correct diameter and wall thickness.
 - j. Cut tube ends square and deburr. Exercise care during cutting to keep tubing round.
 - k. Thread pipe on a threading machine. Ream inner edges of pipe ends, and file and grind to remove burrs.
 - l. Wrap pipe threads with single wrap of PTFE tape.
 - m. Protect piping and tubing from entrance of foreign matter.
 - 7. Do not exceed 50 percent fill capacity where tubing is installed in conduit. Support conduit in accordance with NFPA 70 unless otherwise indicated.
- B. Below-Grade Air Signal Piping and Tubing Installation:
- 1. Install tubing below-grade in a continuous Schedule 80, PVC conduit.

2. Do not exceed 50 percent fill capacity; minimum size 2 inches (50 mm).
3. Install top of conduit at depth of at least 24 inches (600 mm) below finished grade.
4. Install tubing in raceways dedicated to only tubing. Do not combine electrical conductors and tubing in raceways.

C. Identify above-grade piping and tubing as follows:

1. Every 50 ft. (15 m) of straight run.
2. At least once for each branch within 36 inches (900 mm) of main tee.
3. At each change in direction.
4. Within 36 inches (900 mm) of each ceiling, floor, roof, and wall penetration.
5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
6. At each valve.
7. Mark each instrument tube connection with a number-coded identification. Each unique tube is to have same unique number at instrument connection and termination at opposite end of tube.

D. Valve Installation for Pneumatic Tubing:

1. Install valves full size of piping and tubing.
2. Install at the following locations:
 - a. At each branch.
 - b. Before and after each PRV.
 - c. Before and after each air dryer.
 - d. At each control device.
3. Locate valves to be readily accessible from floor.
4. Install needle valves for isolation and throttling applications. [**Option to install ball valves in lieu of needle valves for isolation only applications.**]

3.22 INSTALLATION OF PROCESS TUBING

- A. Install process tubing for signal to instruments in liquid and steam systems. Instruments include, but are not limited to, the following:
 1. Meters.
 2. Sensors.
 3. Switches.
 4. Transmitters.
- B. Support tubing in accordance with MSS SP-58, but at intervals no more than 60 inches (1500 mm) apart.
- C. Install minimum NPS 1/2 (DN 15) process tubing for industrial-grade sensors, transmitters, and switches. Install bushings where required.
- D. Make smooth tubing bends with a bending tool. Flattened or wrinkled bends are unacceptable.
- E. Support tubing independent of other trades.
- F. Route tubing parallel to and at right angles to building construction.
- G. Install tubing concealed in areas with ceilings.
- H. Install dirt leg with an isolation valve and threaded plug in drain valve at each connection to a transmitter and switch.

- I. Insulate process piping and tubing connected to hot water and steam systems for personnel protection if surface temperature exceeds 120 deg F (49 deg C). Only insulate piping and tubing within maintenance personnel reach from floor, platform, or catwalk.
- J. Wrap pipe threads of fitting in process tubing with service temperatures below 350 deg F (177 deg C) with single wrap of PTFE tape.
- K. Coat pipe threads of fittings on process tubing in services with temperatures exceeding 350 deg F (177 deg C) with pipe compound before being made up to reduce possibility of galling.
- L. Do not make tubing connections to a fitting before completing makeup of connection.
- M. Check tubing for correct diameter and wall thickness. Cut the tube ends square and deburred. Exercise care during cutting to keep tubing round.
- N. Do not install fittings close to a bend. Straight length of tubing, not deformed by bending, is required for proper connection.
- O. Align tubing with fitting when installed. Avoid springing tube into position.
- P. Install tubing with extreme care to keep foreign matter out of system. Plug open tubing ends to keep out dust, dirt, and moisture.
- Q. Do not attach tubing to equipment that may be removed frequently for maintenance or may impart vibration and expansion from temperature change.
- R. Protect exposed tubing in mechanical equipment rooms from inadvertent mechanical damage within 96 inches (2400 mm) above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.
- S. Below-Grade Process Tubing Installation:
 - 1. Install tubing below-grade in a continuous Schedule 80, PVC conduit.
 - 2. Do not exceed 50 percent fill capacity; minimum size 2 inches (50 mm).
 - 3. Install top of conduit at depth of at least 24 inches (600 mm) below finished grade.
 - 4. Install tubing in raceways dedicated to only process tubing. Do not combine electrical conductors and tubing in raceways.
- T. Identify above-grade process tubing as follows:
 - 1. Every 50 ft. (15 m) of straight run.
 - 2. At least once for each branch within 36 inches (900 mm) of main tee.
 - 3. Near each change in direction.
 - 4. Within 36 inches (900 mm) of each ceiling, floor, roof, and wall penetration.
 - 5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
 - 6. Near each isolation valve.
 - 7. Mark each instrument tube connection with a number-coded identification. Each unique tube is to have same unique number at instrument connection and termination at opposite end of tube.
- U. Process Tubing Isolation Valves Installation:
 - 1. Install valves full size of piping and tubing.
 - 2. Install isolation valves at the following locations:
 - a. Process connection.
 - b. Inlet to each instrument including, sensors, transmitters, switches, gauges, and other control devices.
 - 3. Locate valves to be readily accessible from floor.

4. Install needle valves for isolation and throttling applications.[**Option to install ball valves in lieu of needle valves for isolation only applications.**]

3.23 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

- A. Comply with NECA 1.
- B. Wire and Cable Installation:
 1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
 2. Comply with installation requirements in Section 271313 "Communications Copper Backbone Cabling."
 3. Comply with installation requirements in Section 271513 "Communications Copper Horizontal Cabling."
 4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
 - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
 5. Terminate wiring in a junction box.
 - a. Clamp cable over jacket in a junction box.
 - b. Individual conductors in the stripped section of cable is to be slack between the clamping point and terminal block.
 6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
 7. Install signal transmission components in accordance with IEEE C2, REA Form 511a, NFPA 70, and as indicated.
 8. Use shielded cable to transmitters.
 9. Use shielded cable to temperature sensors.
 10. Perform continuity and meager testing on wire and cable after installation.
- C. Conduit Installation:
 1. Comply with Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems" for control-voltage conductors.
 2. Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.24 INSTALLATION OF OPTICAL FIBER CABLE SYSTEMS

- A. Comply with installation requirements in Section 271323 "Communications Optical Fiber Backbone Cabling."
- B. Comply with installation requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling."

3.25 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

- C. Tests and Inspections: Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Testing of Air-Signal Tubing:
 - 1. Test for leaks and obstructions.
 - 2. Disconnect each pipe and tubing line before test is performed, and blowout dust, dirt, trash, condensate, and other foreign materials with compressed air. Use commercially pure compressed air or nitrogen as distributed in gas cylinders. Use of compressed air from oil-free compressor with air dryer is an acceptable alternative for test.
 - 3. After foreign matter is expelled and line is free from obstructions, plug far end of tubing run.
 - 4. Connect pressure source to near end of tubing run with needle valve between air supply and tubing run.
 - 5. Connect pressure gauge accurate to within 0.5 percent of test between shutoff needle valve and tubing run under test.
 - 6. For air signal tubing, apply test pressure of 1.5 times instrument operating pressure range. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period to not exceed 0.1 percent of test pressure.
 - 7. For pneumatic system pressures above 30 psig (207 kPa), apply pressure of 1.5 times operating pressure to tubing run. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period to not exceed 1 psig (6.9 kPa).
 - 8. For pneumatic system pressures 30 psig (207 kPa) and below, apply pressure of 1.5 times operating pressure to tubing run. Record pressure in tubing run every five minutes for one hour. Allowable drop in pressure in one-hour period to not exceed 0.5 psig (3.5 kPa).
- E. Optical Fiber Cable Testing:
 - 1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
 - 2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. At a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
 - 3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
 - 4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Perform testing according to test plan supplied by DDC system manufacturer. Correct defective Work or material and retest. At a minimum, final testing for cable system, including spare cable, to verify compliance of attenuation, length, and bandwidth parameters with performance indicated.
 - 5. Test Equipment: Use optical fiber time-domain reflectometer for testing of length and optical connectivity.
 - 6. Test Results: Record test results and submit copy of test results for Project record.

3.26 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests, and calibration.

- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
- E. For pneumatic products, verify that air supply for each product is properly installed.
- F. Control Damper Checkout:
 - 1. For pneumatic control dampers, verify that pressure gauges are provided in each air line connected to the damper actuator and positioner.
 - 2. Verify that control dampers are installed correctly for flow direction.
 - 3. Verify that proper blade alignment, either parallel or opposed, has been provided.
 - 4. Verify that damper frame attachment is properly secured and sealed.
 - 5. Verify that damper actuator and linkage attachment are secure.
 - 6. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
 - 7. Verify that damper blade travel is unobstructed.
- G. Control Valve Checkout:
 - 1. For pneumatic control valves, verify that pressure gauges are provided in each air line connected to the valve actuator and positioner.
 - 2. Verify that control valves are installed correctly for flow direction.
 - 3. Verify that valve body attachment is properly secured and sealed.
 - 4. Verify that valve actuator and linkage attachment are secure.
 - 5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
 - 6. Verify that valve ball, disc, or plug travel is unobstructed.
 - 7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace valve if leaks persist.
- H. Instrument Checkout:
 - 1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
 - 2. Verify that attachment is properly secured and sealed.
 - 3. Verify that conduit connections are properly secured and sealed.
 - 4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
 - 5. Inspect instrument tag against approved submittal.
 - 6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
 - 7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
 - 8. For temperature instruments, verify the following:
 - a. Sensing element type and proper material.
 - b. Length and insertion.

3.27 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION, AND TESTING

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

- C. For each analog instrument, make three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
 - 1. Use field testing and diagnostic instruments and equipment with an accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.
- F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.
- G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.
- H. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated.
- I. Analog Signals:
 - 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 - 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 - 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- J. Digital Signals:
 - 1. Check digital signals using a jumper wire.
 - 2. Check digital signals using an ohmmeter to test for contact making or breaking.
- K. Control Dampers:
 - 1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
 - 2. Stroke pneumatic control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
 - 3. Check and document open and close cycle times for applications with cycle time less than 30 seconds.
 - 4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- L. Control Valves:
 - 1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
 - 2. Stroke pneumatic control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
 - 3. Check and document open and close cycle times for applications with cycle time less than 30 seconds.
 - 4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- M. Meters: Check meters at zero, 50, and 100 percent of Project design values.

- N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
- O. Switches: Calibrate switches to make or break contact at set points indicated.
- P. Transmitters:
 - 1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
 - 2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.28 DDC SYSTEM CONTROLLER CHECKOUT

- A. Verify power supply.
 - 1. Verify voltage, phase, and hertz.
 - 2. Verify that protection from power surges is installed and functioning.
 - 3. Verify that ground fault protection is installed.
 - 4. If applicable, verify if connected to UPS unit.
 - 5. If applicable, verify if connected to backup power source.
 - 6. If applicable, verify that power conditioning units are installed.
- B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.
- C. Verify that spare I/O capacity is provided.

3.29 DDC CONTROLLER I/O CONTROL LOOP TESTS

- A. Testing:
 - 1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
 - 2. Test every I/O point throughout its full operating range.
 - 3. Test every control loop to verify that operation is stable and accurate.
 - 4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
 - 5. Test and adjust every control loop for proper operation according to sequence of operation.
 - 6. Test software and hardware interlocks for proper operation. Correct deficiencies.
 - 7. Operate each analog point at the following:
 - a. Upper quarter of range.
 - b. Lower quarter of range.
 - c. At midpoint of range.
 - 8. Exercise each binary point.
 - 9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller, and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller, and at field instrument must match.
 - 10. Prepare and submit report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

3.30 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

- B. After [review] [approval] of Pretest Checklist and Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed Pretest Checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
 - 1. Detailed explanation for any items that are not completed or verified.
 - 2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
 - 3. HVAC equipment motors operate below full-load amperage ratings.
 - 4. Required DDC system components, wiring, and accessories are installed.
 - 5. Installed DDC system architecture matches approved Drawings.
 - 6. Control electric power circuits operate at proper voltage and are free from faults.
 - 7. Required surge protection is installed.
 - 8. DDC system network communications function properly, including uploading and downloading programming changes.
 - 9. Using BACnet protocol analyzer, verify that communications are error free.
 - 10. Each controller's programming is backed up.
 - 11. Equipment, products, tubing, wiring cable, and conduits are properly labeled.
 - 12. All I/O points are programmed into controllers.
 - 13. Testing, adjusting, and balancing work affecting controls is complete.
 - 14. Dampers and actuators zero and span adjustments are set properly.
 - 15. Each control damper and actuator goes to failed position on loss of power[**and loss of signal**].
 - 16. Valves and actuators zero and span adjustments are set properly.
 - 17. Each control valve and actuator goes to failed position on loss of power[**and loss of signal**].
 - 18. Meter, sensor, and transmitter readings are accurate and calibrated.
 - 19. Control loops are tuned for smooth and stable operation.
 - 20. View trend data where applicable.
 - 21. Each controller works properly in standalone mode.
 - 22. Safety controls and devices function properly.
 - 23. Interfaces with fire-alarm system function properly.
 - 24. Electrical interlocks function properly.
 - 25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphics are created.
 - 26. Record Drawings are completed.
 - 27. **<Insert additional requirements>**.
- E. Test Plan:
 - 1. Prepare and submit validation Test Plan including test procedures for performance validation tests.
 - 2. Address all specified functions of DDC system and sequences of operation in Test Plan.
 - 3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
 - 4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
 - 5. Include Test Checklist to be used to check and initial that each test has been successfully completed.
 - 6. Submit Test Plan documentation 10 business days before start of tests.
- F. Validation Test:
 - 1. Verify operating performance of each I/O point in DDC system.
 - a. Verify analog I/O points at operating value.

- b. Make adjustments to out-of-tolerance I/O points.
 - 1) Identify I/O points for future reference.
 - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
 - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
 2. Simulate conditions to demonstrate proper sequence of control.
 3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
 4. 24 hours after initial validation test, do as follows:
 - a. Re-check I/O points that required corrections during initial test.
 - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
 5. 24 Hours after second validation test, do as follows:
 - a. Re-check I/O points that required corrections during second test.
 - b. Continue validation testing until I/O point is normal on two consecutive tests.
 6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
 7. After validation testing is complete, prepare and submit report indicating results of testing. For all I/O points that required correction, indicate how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.
 - G. DDC System Response Time Test:
 1. Simulate HLC.
 - a. Heavy load to be occurrence of 50 percent of total connected binary COV, one-half of which represents "alarm" condition, and 50 percent of total connected analog COV, one-half of which represents "alarm" condition, that are initiated simultaneously on a one-time basis.
 2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
 3. Measure with timer having at least 0.1-second resolution and 0.01 percent accuracy.
 4. Purpose of test is to demonstrate DDC system, as follows:
 - a. Reaction to COV and alarm conditions during HLC.
 - b. Ability to update DDC system database during HLC.
 5. Passing test is contingent on the following:
 - a. Alarm reporting at printer beginning no more than two seconds after initiation (time zero) of HLC.
 - b. All alarms, both binary and analog, are reported and printed; none are lost.
 - c. Compliance with response times specified.
 6. Prepare and submit report documenting HLC tested and results of test including time stamp and print out of all alarms.
 - H. DDC System Network Bandwidth Test:
 1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.

2. To pass, none of DDC system networks are to use more than 70 percent of available bandwidth under normal and HLC operation.

3.31 VERIFICATION OF DDC SYSTEM WIRELESS NETWORK

- A. DDC system Installer is to design wireless DDC system networks to comply with performance requirements indicated.
- B. Verify wireless network performance through field testing and document results in a field test report.
- C. Testing and verification of all wireless devices to include, but not be limited to, the following:
 1. Speed.
 2. Online status.
 3. Signal strength.

3.32 FINAL REVIEW

- A. Submit written request to Architect **[Owner] [Commissioning Agent] [and] [Construction Manager]** when DDC system is ready for final review. State the following:
 1. DDC system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
 2. DDC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
 3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
 4. DDC system is complete and ready for final review.
 5. **<Insert additional requirements>.**
- B. Upon receipt of written request for final review, **[Architect] [Owner] [Commissioning Agent] [and] [Construction Manager]** to start review within 10 business days and upon completion issue field report(s) documenting observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Compensation for Subsequent Reviews: Should more than two reviews be required, DDC system manufacturer and Installer to compensate entity/entities performing reviews for total costs (labor and expenses) associated with subsequent reviews. Estimated cost of each subsequent review to be submitted and approved by DDC system manufacturer and Installer before review.
- E. Prepare and submit closeout submittals[**and begin procedures indicated in "Extended Operation Test" Article**] when no deficiencies are reported.
- F. Part of DDC system final review to include demonstration to parties participating in final review.
 1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
 2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.

3. Demonstration to include, but not be limited to, the following:
 - a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
 - b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points to be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
 - c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
 - d. Operation of randomly selected dampers and valves in normal-on, normal-off, and failed positions.
 - e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
 - f. Trends, summaries, logs, and reports set up for Project.
 - g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
 - h. Software's ability to communicate with controllers, operator workstations, and uploading and downloading of control programs.
 - i. Software's ability to edit control programs offline.
 - j. Data entry to show Project-specific customizing capability including parameter changes.
 - k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
 - l. Execution of digital and analog commands in graphic mode.
 - m. Spreadsheet and curve plot software and its integration with database.
 - n. Online user guide and help functions.
 - o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
 - p. System speed of response compared to requirements indicated.
 - q. For Each Controller: Applies to network and programmable application controllers.
 - 1) Memory: Programmed data, parameters, trend, and alarm history collected during normal operation are not to be lost during power failure.
 - 2) Operator Interface: Ability to connect directly to each type of digital controller with portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
 - 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
 - 4) Electric Power: Ability to disconnect any controller safely from its power source.
 - 5) Wiring Labels: Match control drawings.
 - 6) Network Communication: Ability to locate controller's location on network and communication architecture matches Shop Drawings.
 - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

- r. For Each Operator Workstation:
 - 1) I/O points lists agree with naming conventions.
 - 2) Graphics are complete.
 - 3) UPS unit, if applicable, operates.
- s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management.[**Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability.**] Requirements must be met even if only one manufacturer's equipment is installed.
 - 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
 - 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
 - 3) Set-Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.[**Modifications are made with messages and write services initiated by operator using workstation graphics, or by completing a field in menu with instructional text.**]
 - 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
 - 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
 - 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
 - 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
 - 8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
 - 9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
 - 10) Device and Network Management:
 - a) Display of network device status.
 - b) Display of BACnet object information.
 - c) Silencing devices transmitting erroneous data.
 - d) Time synchronization.
 - e) Remote device re-initialization.
 - f) Backup and restore network device programming and master database(s).
 - g) Configuration management of routers.
- t. <Insert additional requirements>.

3.33 EXTENDED OPERATION TEST

- A. Operate DDC system for operating period of 21 consecutive calendar days following Substantial Completion. Coordinate exact start date of testing with Owner.
- B. Provide operator familiar with DDC system installed to man an operator workstation [**while on-site**] during eight hours of each normal business day occurring during operating period.

- C. During operating period, DDC system to demonstrate correct operation and accuracy of monitored and controlled points as well as operation capabilities of sequences, logs, trends, reports, specialized control algorithms, diagnostics, and other software indicated.
 - 1. Correct defects of hardware and software when they occur.
- D. Definition of Failures and Downtime during Operating Period:
 - 1. Failed I/O point constituting downtime is I/O point failing to perform its intended function consistently and a point physically failed due to hardware and software.
 - 2. Downtime is when any I/O point in DDC system is unable to fulfill its required function.
 - 3. Calculate downtime as elapsed time between detected point failure as confirmed by operator, and time point is restored to service.
 - 4. Maximum time interval allowed between DDC system detection of failure occurrence and operator confirmation is to be 0.5 hours.
 - 5. Log downtime in hours to nearest 0.1 hour.
 - 6. Power outages do not count as downtime but do suspend test hours unless systems are provided with UPS and served through a backup power source.
 - 7. Hardware or software failures caused by power outages do count as downtime.
- E. During operating period, log downtime and operational problems are encountered.
 - 1. Identify source of problem.
 - 2. Provide written description of corrective action taken.
 - 3. Record duration of downtime.
 - 4. Maintain log showing the following:
 - a. Time of occurrence.
 - b. Description of each occurrence and pertinent written comments for reviewer to understand scope and extent of occurrence.
 - c. Downtime for each failed I/O point.
 - d. Running total of downtime and total time of I/O point after each problem has been restored.
 - 5. Make log available to Owner for review at any time.
- F. For DDC system to pass extended operation test, total downtime is limited to 1 percent of total point-hours during operating period.
 - 1. If DDC system testing results fail to comply with minimum requirements of passing at end of operating period indicated, extend operating period one consecutive day at a time until DDC system passes requirement.
- G. Base evaluation of DDC system passing test on the following calculation:
 - 1. Count downtime on point-hour basis where total number of DDC system point-hours is equal to total number of I/O points in DDC system multiplied by total number of hours during operating period.
 - 2. One point-hour of downtime is one I/O point down for one hour. For example, three I/O points down for five hours is total of 15 point-hours of downtime. Four points down for one-half hour is two point-hours of downtime.
 - 3. Example Calculation: Maximum allowable downtime for 30-day test for DDC system with 1000 total I/O points (combined analog and binary) and passing score of 1 percent downtime is computed by 30 days x 24 h/day x 1000 points x 1 percent equals 7200 point-hours of maximum allowable downtime.
- H. Prepare test and inspection reports.

3.34 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.35 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, verify that maintenance service includes **[three] [six] [nine] [12]** months' full maintenance by DDC system manufacturer's authorized service representative. Include **[monthly] [quarterly] [semiannual] [annual]** preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration, and adjusting as required for proper operation. Use only manufacturer's authorized replacement parts and supplies.

3.36 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, verify that service agreement includes software support for **[one] [two]** year(s).
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within **[one] [two]** year(s) from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: No fewer than **[30]** days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.37 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Extent of Training:
 - 1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
 - 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
 - 3. Minimum Training Requirements:
 - a. Provide not less than **[five] [10] [15]** days of training total.
 - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training to occur before end of warranty period.
 - c. Break down total days of training into not more than **[two] [three] [four]** separate training classes.
 - d. Schedule training so each training class is not less than **[one] [two] [three]** consecutive day(s).
- C. Training Schedule:
 - 1. Schedule training with Owner 20 business days before expected Substantial Completion.
 - 2. Schedule training to provide Owner with at least **[10] [15] [20]** business days of notice in advance of training.

3. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session to be split in half with **[15] [30]**-minute break between sessions. Morning and afternoon sessions to be separated by **[30] [60]**-minute lunch period. Training, including breaks and excluding lunch period, are not to exceed eight hours per day.
 4. Provide staggered training schedule as requested by Owner.
- D. Training Attendee List and Sign-in Sheet:
1. Request from Owner in advance of training a proposed attendee list with name, phone number, and email address.
 2. Provide preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
 3. Include preprinted sign-in sheet with training session number, date and time, instructor name, phone number, email address, and brief description of content to be covered during session. List attendees with columns for name, phone number, and email address and a column for attendee signature or initials.
 4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
 5. At end of each training day, send Owner an email with attachment of scanned copy (PDF) of circulated sign-in sheet for each session. **[Indicate which attendees, if any, joined for only part of training sessions].**
- E. Training Attendee Headcount:
1. Plan in advance of training for **[two] [three] [five]** attendees.
 2. Make allowance for Owner to add up to **[one] [two]** attendee(s) at time of training.
 3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.
- F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:
1. **[High school] [High school and technical school] [High school and four-year college] <Insert level>** education and degree.
 2. **[Basic] [Intermediate] [Advanced]** user knowledge of computers and office applications.
 3. **[Basic] [Intermediate] [Advanced]** knowledge of HVAC systems.
 4. **[Basic] [Intermediate] [Advanced]** knowledge of DDC systems.
 5. **[Basic] [Intermediate] [Advanced]** knowledge of DDC system and products installed.
- G. Attendee Training Manuals:
1. Provide each attendee with color hard copy of all training materials and visual presentations.
 2. Organize hard-copy materials in three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
 3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes DVD or flash drive with PDF copy of all hard-copy materials.
- H. Instructor Requirements:
1. One or multiple qualified instructors, as required, to provide training.
 2. Use instructors who have provided not less than five years of instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

I. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
 - a. Daily operators.
 - b. Advanced operators.
 - c. System managers and administrators.
2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions to ensure DDC system security.

J. Training Outline:

1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Include in outline a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session, and synopses for each lesson planned.

K. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. Use operator workstation that is to be used with DDC system in the training. If operator workstations are unavailable, provide temporary workstation to convey training content.

L. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.
3. Provide operator workstation for use by each attendee.

M. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm, and each unique optimization routine.
5. Operating operator workstations, printers, and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports, and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.

13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
 - a. Operation of HVAC equipment in normal-off, normal-on, and failed conditions while observing individual equipment, dampers, and valves for correct position under each condition.
 - b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
 - c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles, and other modes of operation indicated.
 - d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
 - e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
 - f. Each control loop responds to set-point adjustment and stabilizes within time period indicated.
 - g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.
 - h. <Insert requirement>.

N. Training Content for Advanced Operators:

1. Making and changing workstation graphics.
2. Creating, deleting, and modifying alarms including annunciation and routing.
3. Creating, deleting, and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting, and modifying reports.
5. Creating, deleting, and modifying points.
6. Creating, deleting, and modifying programming including ability to edit control programs offline.
7. Creating, deleting, and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.

10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring DDC system hardware including controllers, workstations, communication devices, and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing, and repairing hardware.
15. Adjusting, calibrating, and replacing DDC system components.
16. **<Insert requirement>**.

O. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading, and offline archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.
9. **<Insert requirement>**.

P. Video of Training Sessions:

1. Provide digital video and audio recording of each training session. Create separate recording file for each session.
2. Stamp each recording file with training session number, session name, and date.
3. Provide Owner with two copies of digital files on cloud and flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION 230923

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

- 1.1 Indoor Piping is expected to be copper up to sizes listed, outdoor piping should be steel with the exception of retrofit/renovation applications.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following:
1. Material reuse.
 2. Recycled content.
 3. Adhesives: VOC content and emissions evaluation.
- B. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Section 230548 "Vibration and Seismic Controls for HVAC."
- C. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
1. Hot-Water Heating Piping: 100 psig (689 kPa) at 200 deg F (93 deg C) .
 2. Chilled-Water Piping: 150 psig (1034 kPa) 100 deg F (38 deg C).
 3. Condenser-Water Piping: 150 psig (1034 kPa) at 73 deg F (66 deg C).
 4. Glycol Cooling-Water Piping: 150 psig (1034 kPa) at 150 deg F (66 deg C).
 5. Makeup-Water Piping: 80 psig (552 kPa) at 73 deg F (22 deg C).
 6. Condensate-Drain Piping: 150 deg F (66 deg C).
 7. Air-Vent Piping: 200 deg F (93 deg C).
 8. Pressure-Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L (ASTM B88M, Type B).
- B. Annealed-Temper Copper Tube: ASTM B88, Type K (ASTM B88M, Type A) .
- C. DWV Copper Tube: ASTM B306, Type DWV.
- D. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- E. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- G. Cast-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. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- H. Wrought-Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- I. Grooved, Mechanical-Joint, Copper Tube Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - b. Star Pipe Products.
 - c. Victaulic Company.
2. Source Limitations: Obtain grooved mechanical-joint copper tube appurtenances from single manufacturer.
3. Grooved-End Copper Fittings: ASTM B75 (ASTM B75M) copper tube or ASTM B584 bronze castings.
4. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM gasket rated for minimum 230 deg F (110 deg C) for use with ferrous housing, and steel bolts and nuts; 300 psig (2060 kPa) minimum CWP pressure rating.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M black steel with plain ends; welded and seamless, Grade B, and schedule number 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 "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A234/A234M; wall thickness to match adjoining pipe.
- G. 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. Grooved Mechanical-Joint Fittings and Couplings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Grinnel Mechanical Products.
 - b. Nexus Valve, Inc.; Aalberts Hydronic Flow Control.
 - c. Star Pipe Products.
 - d. Victaulic Company.
 2. Source Limitations: Obtain grooved mechanical-joint fittings and couplings from single manufacturer.
 3. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

4. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. HART Industrial Unions, LLC.
 - e. Jomar Valve.
 - f. Matco-Norca.
 - g. WATTS.
 - h. Wilkins.
 - i. Zurn Industries, LLC.
 2. Source Limitations: Obtain dielectric unions from single manufacturer.
 3. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: [125 psig (860 kPa) minimum at 180 deg F (82 deg C)] [150 psig (1035 kPa)] [250 psig (1725 kPa)] .
 - c. End Connections: Solder-joint copper alloy and threaded ferrous. Solder joints are not to be used on pipe sizes greater than NPS 4 (DN 100).
- C. Dielectric-Flange Insulating Kits:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. Calpico, Inc.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. GPT; a division of EnPRO Industries.
 2. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
 3. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig (1035 kPa) .
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- D. Dielectric Nipples:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - b. Elster Perfection; a Honeywell Company.
 - c. GPT; a division of EnPRO Industries.

- d. Matco-Norca.
 - e. Precision Plumbing Products.
 - f. Sioux Chief Manufacturing Company, Inc.
 - g. Victaulic Company.
2. Source Limitations: Obtain dielectric nipples from single manufacturer.
3. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F1545.
 - c. Pressure Rating: Minimum 300 psig (2070 kPa) at 225 deg F (107 deg C).
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-Water Heating Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:
 1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40, Grade B, steel pipe; Class 150, malleable-iron fittings; and grooved mechanical joints.
- B. Hot-Water Heating Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 1. Schedule 40, Grade B, steel pipe; Class 150, malleable-iron fittings; welded joints, cast-iron flanges, flange-fittings, and flanged joints.
 2. Schedule 40, Grade B, steel pipe; grooved mechanical joint coupling and fittings; and grooved mechanical joints.
- C. Chilled-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to be Any of the Following:
 1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40, Grade B steel pipe; Class 150, malleable-iron fittings; and grooved mechanical joints.
- D. Chilled-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 1. Schedule 40, Grade B, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 2. Schedule 40, Grade B, steel pipe; grooved mechanical joint coupling and fittings; and grooved mechanical joints.
- E. Condenser-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:
 1. Schedule 40, Grade B, steel pipe; Class 150, malleable-iron, fittings; and threaded grooved mechanical joints.
- F. Condenser-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 1. Schedule 40, Grade B, steel pipe, Class 150, malleable-iron fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.
 2. Schedule 40, Grade B, steel pipe; grooved, mechanical joint coupling and fittings; and grooved mechanical joints.

- G. Glycol Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:
 - 1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Schedule 40, steel pipe; Class 150, malleable-iron fittings; and threaded joints.
- H. Glycol Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:
 - 1. Schedule 40, Grade B, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 - 2. Schedule 40, Grade B, steel pipe; grooved, mechanical joint coupling and fittings; and grooved mechanical joints.
- I. Makeup-Water Piping Installed Aboveground to Be Any of the Following:
 - 1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal mechanical grooved joints.
- J. Condensate-Drain Piping Installed Aboveground to Be Any of the Following:
 - 1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal grooved mechanical joints.
- K. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.
 - 2. Outlet: Type K (Type A), annealed-temper copper tubing with soldered or flared joints.
- L. Pressure-Relief-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed, with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.

3.2 INSTALLATION OF PIPING

- A. 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.
- 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, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) 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 the following:
 - 1. Section 230523.11 "Globe Valves for HVAC Piping."
 - 2. Section 230523.12 "Ball Valves for HVAC Piping."
 - 3. Section 230523.13 "Butterfly Valves for HVAC Piping."
 - 4. Section 230523.14 "Check Valves for HVAC Piping."
 - 5. Section 230523.15 "Gate Valves for HVAC Piping."
- Q. Install air vents and pressure-relief valves in accordance with Section 232116 "Hydronic Piping Specialties."
- R. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- S. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
- T. Install shutoff valve immediately upstream of each dielectric fitting.
- U. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

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 pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with 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 in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "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.
- G. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- H. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.
- 3.4 INSTALLATION OF DIELECTRIC FITTINGS
- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
- C. Dielectric Fittings for NPS 2-1/2 and Larger Use dielectric flange kits.
- 3.5 INSTALLATION OF HANGERS AND SUPPORTS
- A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
- E. Support vertical runs of copper tubing and steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- 3.6 TERMINAL EQUIPMENT CONNECTIONS
- A. Sizes for supply and return piping connections are to 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 gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gauges for HVAC Piping."

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.8 SYSTEM STARTUP

- A. 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.

3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping in accordance with 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 is to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install pressure-relief 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 is not to 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 the "SE" value in Appendix A in ASME B31.9.
 - 5. After hydrostatic test pressure has been applied for at least 10 minutes, 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.

END OF SECTION 232113

SECTION 235213 - ELECTRIC BOILERS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Acme Engineering Prod. Inc.
 2. Argo Technology, Inc.
 3. Benjamin Heating Products.
 4. Bryan Boilers; Bryan Steam LLC.
 5. Cleaver-Brooks.
 6. Fulton Boiler Works, Inc.
 7. Lattner Boiler Manufacturing.
 8. Lion Boilers/Division of Concept Manufacturing Inc.
 - 9.
 10. Patterson-Kelley.
 11. Precision Boilers.
 12. PVI; A WATTS Brand.
 13. Reimers Electra Steam, Inc.
 14. Sussman Electric Boilers.
 15. Raypak
 16. Parker

2.3 MANUFACTURED UNITS

- A. Description: Factory-fabricated, -assembled, and -tested electric boilers with trim and controls necessary to generate hot water.
- B. Pressure Vessel: Carbon-steel pressure vessel mounted on structural-steel base.
- C. Nozzles: Flanges for water inlet and outlet and heating element inserts; threaded connections for trim and controls.
- D. Insulation: One layer of minimum 1-inch- (25-mm-) thick, glass-fiber insulation.
- E. Jacket: sheet metal casing with baked-enamel or powder-coated protective finish and removable panels with snap-in or interlocking closures for access to pressure vessel.
- F. Lifting Lugs: Welded to pressure vessel, extending above jacket.
- G. Heating Elements: [**Copper**] [**Incoloy**]-sheathed, replaceable electric-resistance element, rated 20-kW maximum, with maximum [**50 W/sq. in. (7.7 W/sq. cm)**] [**75 W/sq. in. (11.5 W/sq. cm)**] <Insert value> over heat-transfer length.
- H. Mounting Base: For securing boiler to concrete base.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.
- I. 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.
- J. ASME Compliance: Fabricate and label boilers to comply with 2013 ASME Boiler and Pressure Vessel Code.
- K. NFPA Compliance: Design and fabricate boilers to comply with NFPA 70, Article 424, Paragraphs G and H.
- L. UL Compliance: Test boilers for compliance with UL 834. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- M. CSA Compliance: Test boilers for compliance with CSA B51.

2.4 TRIM FOR HOT-WATER BOILERS

Include devices sized to comply with ASME B31.9.

- A. Include Integral Control Panel.
- B. Aquastat Controllers: Operating auto-reset high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- E. Boiler Air Vent: Automatic.
- F. Dip-tube in water outlet.
- G. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end ball valve sized according to requirements of authorities having jurisdiction.
- H. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of pressure vessel and sealed with fiber gasket.
 1. Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
 2. Tappings NPS 2-1/2 (DN 65) 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.

2.5 CONTROLS

- A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
- B. Boiler operating controls shall include the following devices and features:
 1. Control transformer.
 2. Step controller.
 3. Recycling relay returns controller to off position after power failure.
 4. Multistage thermostat.
 5. Control-circuit switch.
 6. Visual indication for each step.

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7. Supply-voltage indicator.
 8. Set-Point Adjust: Set points shall be adjustable.
 9. Operating Level Control: Factory wired and mounted to cycle feedwater pump(s) for makeup water control.
 10. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control element sequence controller to maintain space temperature in response to thermostat with heat anticipator located in heated space.
 - a. Include automatic, alternating-operation sequence for multiple boilers to provide equal runtime for boilers.
- C. Safety Controls: To maintain safe operating conditions, safety controls limit boiler operation.
1. High Cutoff: Automatic reset stops boiler if operating conditions rise above set point or maximum boiler design temperature.
 2. Low-Water Cutoff Switch: Electronic probe shall prevent boiler operation on low water. Cutoff switch shall be automatic-reset type.
 3. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- D. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.
1. Hardwired Points:
 - a. Monitoring: On/off status, low-water-level alarm.
 - b. Control: On/off operation, hot water supply temperature set-point adjustment.
 2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available and monitoring points displayed locally at boiler control panel shall be available through building management system.

2.6 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, transformers, and electrical devices necessary shall provide a single-point field power connection to boiler.
1. Field power interface shall be to circuit breaker.
 2. Interlock with door to de-energize power with door open.
- B. Electrical Enclosures: NEMA 250
1. Indoor: Type 1 enclosure with hinged door and key-locking handle.
 2. Outdoor: Type 3R enclosure with hinged door and key-locking handle.
- C. Install factory wiring outside of an enclosure in a metal raceway.
- D. Comply with NFPA 70.
1. Electrical Circuits: 48 A, maximum.
- E. Connectors: Mechanical lugs bolted to copper bus bars or distribution blocks with pressure connectors.
- F. Fuses: NEMA FU 1, Class J or K5; 60 A, maximum.
- G. Contactors: Three-pole magnetic contactors, listed for 500,000 cycles at full load.
- H. Factory-wired internal control devices and heating elements.
1. Wiring shall be numbered and color coded to match wiring diagram.

2.7 SOURCE QUALITY CONTROL

- A. Test and inspect factory-assembled boilers, before shipping, according to 2013 ASME Boiler and Pressure Vessel Code.
- B. Hydrostatic Test: Factory test assembled boiler, including hydrostatic test.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

END OF SECTION 235213

SECTION 236416 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain centrifugal chillers from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following:
 - 1. Adhesives: VOC content and emissions evaluation.
 - 2. Sealants: VOC content and emissions evaluation.
- B. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."
- C. Condenser-Fluid Temperature Performance:
 - 1. Startup Condenser-Fluid Temperature: Chiller is to be capable of starting with an entering condenser-fluid temperature of **[60 deg F (16 deg C)] [55 deg F (13 deg C)] [40 deg F (4 deg C)] <Insert temperature>** and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
 - 2. Minimum Operating Condenser-Fluid Temperature: Chiller is to be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of **[65 deg F (18 deg C)] [60 deg F (16 deg C)] [55 deg F (13 deg C)]**.
 - 3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.
- D. Site Altitude: Chiller is to be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
- E. ASHRAE Compliance:
 - 1. ASHRAE 15 for safety code for mechanical refrigeration.
 - 2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
 - 3. ASHRAE/IES 90.1.
- F. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-134a, R-513A, or R-1234ze(E) refrigerant, include an ASME U-stamp and nameplate certifying compliance.
- 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 application.
- H. Comply with requirements of Underwriters Laboratories, and include label by a qualified testing agency showing compliance.

I. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system are to automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought online.
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement, even if not explicitly indicated.

J. Outdoor Installations:

1. Chiller must be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a [25] <Insert number>-year period, with minimal degradation due to exposure to outdoor ambient conditions.
2. Chillers are equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past [30] <Insert number>-year period.

2.3 CENTRIFUGAL WATER CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Global Corporation.
2. Daikin Applied.
3. Trane.
4. YORK; brand of Johnson Controls International plc, Building Solutions North America.
5. <

B. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, [**lubrication system**]evaporator, condenser, [**heat-reclaim condenser as indicated,**]controls, interconnecting unit piping and wiring, and indicated accessories.

1. Multi-Piece Assembly: Disassemble chiller into major assemblies as required by the installation after factory testing[**and before packaging for shipment**].
2. Dual-Compressor Chillers: For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails.

C. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

D. Compressor-Drive Assembly: Single-stage or multistage, variable- or dynamic-displacement, centrifugal-type compressor driven by an electric motor.

1. Oil-Free Technology:

- a. Where indicated, compressors must have oil-free technology using a permanent magnet synchronous motor, magnetic bearings, integral variable-frequency controller, and digital electronic controls.

1) Magnetic Bearings or Roller Element Bearings:

- a) Levitated shaft position is to be actively controlled and monitored by an X-, Y-, and Z-axis digital position sensor.

- b) Compressor assembly is to be capable of coming to a controlled, safe stop without damage during a power failure by diverting stored power to the magnetic bearing control system.
 - 2) Integrate monitoring and controls associated with magnetic bearings into chiller controls, including following:
 - a) Operating Information: Positions, currents, temperatures, rotor elongation, and speed.
 - b) Warning Messages: Vibration.
 - c) Safety Shutdown: Internal fault, high bearing temperature or current, startup failure, speed signal fault, overspeed fault, communication error, rotor elongation, oscillator fault, rotor contraction, unauthorized rotation, and high and low voltage.
 - d) Cycling Shutdown: Position, low-frequency displacement, vibration, speed signal fault, startup failure, serial communications fault.
- 2. Compressor:
 - a. Casing: Cast iron, precision ground.
 - b. Impeller: High-strength cast-aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.
- 3. Drive: Direct- or gear-drive, open or hermetic design, using an electric motor as the driver.
 - a. Gear Drives:
 - 1) For chillers with oil-lubricated gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating.
 - 2) For chillers with oil-free technology, gear drives are to be of single- or double-helical gear design without the need for oil while chiller is operating, starting, and stopping.
 - 3) Gears must comply with American Gear Manufacturer Association standards.
 - b. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
 - c. Seals: Seal drive assembly to prevent refrigerant leakage.
- 4. Compressor Motor:
 - a. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
 - b. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
 - c. Motor is to be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
 - d. For chillers with open drives, provide motor with **[open-dripproof] [weather-protected, Type I] [weather-protected, Type II] [totally enclosed]** enclosure.
 - e. Provide motor with thermistor or RTD in **[single motor winding] [each of three-phase motor windings]** to monitor temperature and report information to chiller control panel.
 - f. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
 - g. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.

5. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
 - a. Overspeed Test: At least 20 percent above design operating speed.
 - b. Vibration Limits: Velocities not to exceed 0.15 inch/s (3.8 mm/s) and 0.8 mil (0.02 mm) peak to peak on all axes.
6. Service: Easily accessible for inspection and service.
 - a. Compressor's internal components are to be accessible without having to remove compressor-drive assembly from chiller.
 - b. Provide lifting lugs or eyebolts attached to casing.
7. Economizers: For multistage chillers, provide interstage economizers.
8. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.
 - a. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
 - b. Operating Range: From 100 to [15] [10] [5] [zero] <Insert number> percent of design capacity.
 - c. Condenser-Fluid Unloading Requirements over Operating Range: **[Constant-design of entering condenser-fluid temperature] [Drop-in entering condenser-fluid temperature of 2.5 deg F (1.4 deg C) for each 10 percent in capacity reduction] <Insert conditions>**.
 - d. Chillers with variable-frequency controllers must modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
 - e. Avoid use of hot-gas bypass if other options are available to achieve performance indicated. Apply hot-gas bypass according to ASHRAE/IES 90.1 and governing codes.
9. Oil Lubrication System: Consisting of pump, filtration, heater,]cooler, factory-wired power connection, and controls.
 - a. Bearings, gears, and other rotating surfaces are to be lubricated at all operating, startup, coast down, and standby conditions, including power failure.
 - b. Manufacturer's standard method to remove refrigerant from oil.
 - c. **[Oil filter] [Dual oil filters, one redundant,]** to be the easily replaceable cartridge type, minimum [0.3] [0.5]-micron efficiency, with means of positive isolation while servicing.
 - d. **[Refrigerant] [Water] [Refrigerant- or water]**-cooled oil cooler.
 - e. Factory-installed and pressure-tested piping with isolation valves and accessories.
 - f. Oil compatible with refrigerant and chiller components.
 - g. Positive visual indication of oil level.
- E. Refrigeration:
 1. Refrigerant:
 - a. Type: **[R-134a; ASHRAE 34, Class A1] [R-513A; ASHRAE 34, Class A1] [R-514A; ASHRAE 34, Class B1] [R-1233zd(E); ASHRAE 34, Class A1] [R-1234ze(E); ASHRAE 34, Class A2L]**.
 - b. Compatibility: Chiller parts exposed to refrigerants are to be fully compatible with refrigerants, and pressure components are to be rated for refrigerant pressures.
 2. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.

3. Pressure Relief Device:
 - a. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
 - b. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
 - c. Where dual pressure relief devices are installed in series, provide a sensor with indicator between devices to indicate refrigerant release past first device.
 - d. For Chillers Using R-514A or R-1233zd(E): **[Manufacturer's standard offering complying with ASHRAE 15 and ASHRAE 147] [Rupture disc constructed of frangible carbon] [or] [spring-loaded, pressure relief valve; single- or multiple-reseating type]**.
 - e. For Chillers Using R-134a, R-513A, or R-1234ze(E): ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Provide pressure relief valve(s) for each chiller heat exchanger. Provide condenser with dual valves, one being redundant and configured to allow either valve to be replaced without loss of refrigerant.
4. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.
5. Refrigerant Isolation for Chillers Using R-134a, R-513A, or R-1234ze(E):
 - a. Factory install isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell.
6. Purge System:
 - a. For chillers operating at subatmospheric pressures using R-514A or R-1233zd(E) refrigerant, factory install an automatic purge system for collection and return of refrigerant and lubricating oil and for removal of noncondensables, including, but not limited to, water, water vapor, and noncondensable gases.
 - b. System is to be of thermal purge design, refrigerant or air cooled, and equipped with a carbon filter that includes an automatic regeneration cycle.
 - c. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
 - d. Construct components of noncorrodible materials.
 - e. Controls are to interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
 - f. Efficiency of not more than 0.02 lb of refrigerant per pound of air (9 g of refrigerant per gram of air) when rated according to AHRI 580.
 - g. Operation independent of chiller according to ASHRAE 147.
7. Positive-Pressure System:
 - a. For chillers operating at subatmospheric pressures using R-514A or R-1233zd(E) refrigerant, factory install an automatic positive-pressure system.
 - b. During nonoperational periods, positive-pressure system is to automatically maintain a positive pressure for atmosphere in the refrigerant-pressure vessel of not less than 0.5 psig (3 kPa) adjustable up to a pressure that remains within the vessel design pressure limits.
 - c. Provide factory-wired system including controller, electric heat, pressure transmitter, or switch.

F. Evaporator:

1. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent liquid refrigerant carryover from entering compressor.
4. Evaporator must have sight glass or other form of positive visual verification of liquid-refrigerant level.
5. Tubes:
 - a. Individually replaceable from either end and without damage to tube sheets and other tubes.
 - b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
 - c. Material: **[Copper] [Copper-nickel alloy] [Stainless steel] [Titanium] [Copper, copper-nickel alloy, stainless steel, or titanium]** .
 - d. Nominal OD: **[Manufacturer's choice] [3/4 inch (19 mm)] [1 inch (25 mm)] [3/4 or 1 inch (19 or 25 mm)]**.
 - e. Minimum Wall Thickness: **[Manufacturer's choice] [0.025 inch (0.6 mm)] [0.028 inch (0.7 mm)] [0.035 inch (0.9 mm)] <Insert value>**.
 - f. External Finish: Manufacturer's standard.
 - g. Internal Finish: **[Enhanced] [Smooth] [Enhanced or smooth]**.
6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.
7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
8. Water Box:
 - a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
 - b. **[Standard] [Marine]** type for water box with piping connections; standard type for water box without piping connections.
 - c. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
 - d. **[Hinged] [Davited] [Hinged or davited]** marine water-box covers.
 - e. Nozzle Pipe Connections: **[Welded, ASME B16.5, flat-face flange] [Welded, ASME B16.5, raised-face flange] [Grooved for mechanical-joint coupling] [Grooved with mechanical-joint coupling and flange adapter]**.
 - f. Thermistor or RTD temperature sensor factory installed in each nozzle.
 - g. Fit each water box with **[3/4-inch (19-mm)] [1-inch (25-mm)] [3/4- or 1-inch (19- or 25-mm)] <Insert size>** drain connection at low point and vent connection at high point, each with threaded plug.
9. Additional Corrosion Protection:
 - a. Electrolytic corrosion-inhibitor anode, **[zinc] [or] [magnesium]**.
 - b. Coat wetted surfaces with a corrosion-resistant finish.
 - c. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.
10. Flow Sensor: Thermal dispersion type, factory calibrated for Project-specific application.

G. Condenser:

1. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell. Shell is to be separate from evaporator.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
4. Condenser is to have sight glass or other form of positive visual verification of refrigerant charge and condition.
5. Tubes:
 - a. Individually replaceable from either end and without damage to tube sheets and other tubes.
 - b. Mechanically expanded into end sheets and intermediate tube sheets.
 - c. Material: **[Copper] [Copper-nickel alloy] [Stainless steel] [Titanium] [Copper, copper-nickel alloy, stainless steel, or titanium] <Insert material>**.
 - d. Nominal OD: **[Manufacturer's choice] [3/4 inch (19 mm)] [1 inch (25 mm)] [3/4 or 1 inch (19 or 25 mm)]**.
 - e. Minimum Wall Thickness: **[Manufacturer's choice] [0.025 inch (0.6 mm)] [0.028 inch (0.7 mm)] [0.035 inch (0.9 mm)] <Insert value>**.
 - f. External Finish: Manufacturer's standard.
 - g. Internal Finish: **[Enhanced] [Smooth] [Enhanced or smooth]**.
6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.
7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear[, **but not more than 4 feet (1.2 m) apart**].
8. Water Box:
 - a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
 - b. **[Standard] [Marine]** type for water box with piping connections. Standard type for water box without piping connections.
 - c. Water boxes **[and marine water-box covers]** are to have lifting lugs or eyebolts.
 - d. **[Hinged] [Davited] [Hinged or davited]** marine water-box covers.
 - e. Nozzle Pipe Connections: **[Welded, ASME B16.5, flat-face flange] [Welded, ASME B16.5, raised-face flange] [Grooved for mechanical-joint coupling] [Grooved with mechanical-joint coupling and flange adapter]**.
 - f. Thermistor or RTD temperature sensor factory installed in each nozzle.
 - g. Fit each water box with **[3/4-inch (19-mm)] [1-inch (25-mm)] [3/4- or 1-inch (19- or 25-mm)] <Insert size>** drain connection at low point and vent connection at high point, each with threaded plug.
9. Additional Corrosion Protection:
 - a. Electrolytic corrosion-inhibitor anode, **[zinc] [or] [magnesium]**.
 - b. Coat wetted surfaces with a corrosion-resistant finish.
 - c. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.
10. Flow Sensor: Thermal dispersion type, factory calibrated for Project-specific application.

H. Heat-Reclaim Condenser:

1. Description: Shell-and-tube design, with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator and condenser.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
4. Tubes:
 - a. Individually replaceable from either end and without damage to tube sheets and other tubes.
 - b. Mechanically expanded into end sheets and intermediate tube sheets.
 - c. Material: **[Copper] [Copper-nickel alloy] [Stainless steel] [Titanium] [Copper, copper-nickel alloy, stainless steel, or titanium] <Insert material>**.
 - d. Nominal OD: **[Manufacturer's choice] [3/4 inch (19 mm)] [1 inch (25 mm)] [3/4 or 1 inch (19 or 25 mm)]**.
 - e. Minimum Wall Thickness: **[Manufacturer's choice] [0.025 inch (0.6 mm)] [0.028 inch (0.7 mm)] [0.035 inch (0.9 mm)] <Insert value>**.
 - f. External Finish: Manufacturer's standard.
 - g. Internal Finish: **[Enhanced] [Smooth] [Enhanced or smooth]**.
5. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes, with positive seal between fluid in tubes and refrigerant in shell.
6. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear[, **but not more than 4 feet (1.2 m) apart**].
7. Water Box:
 - a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
 - b. **[Standard] [Marine]** type for water box with piping connections; standard type for water box without piping connections.
 - c. Water boxes **[and marine water-box covers]** are to have lifting lugs or eyebolts.
 - d. **[Hinged] [Davited] [Hinged or davited]** marine water-box covers.
 - e. Nozzle Pipe Connections: **[Welded, ASME B16.5, flat-face flange] [Welded, ASME B16.5, raised-face flange] [Grooved for mechanical-joint coupling] [Grooved with mechanical-joint coupling and flange adapter]**.
 - f. Thermistor or RTD temperature sensor factory installed in each nozzle.
 - g. Fit each water box with **[3/4-inch (19-mm)] [1-inch (25-mm)] [3/4- or 1-inch (19- or 25-mm)] <Insert size>** drain connection at low point and vent connection at high point, each with threaded plug.
8. Additional Corrosion Protection:
 - a. Electrolytic corrosion-inhibitor anode, **[zinc] [or] [magnesium]**.
 - b. Coat wetted surfaces with a corrosion-resistant finish.
 - c. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.
9. Flow Sensor: Thermal dispersion type, factory calibrated for Project-specific application.

I. Insulation:

1. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C534, Type I for tubular materials and Type II for sheet materials.
 - a. Thickness: **[3/4 inch (19 mm)] [1-1/2 inches (38 mm)] <Insert value>**.

2. Adhesive: As recommended by insulation manufacturer.
3. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components include, but are not limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
 - a. Apply adhesive to 100 percent of insulation contact surface.
 - b. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
 - c. Seal seams and joints to provide a vapor barrier.
 - d. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
 - e. Manufacturer has option to factory or field insulate chiller components installed in multiple pieces to reduce potential for damage during installation.
 - f. Manufacturer has option to factory or field insulate water boxes and nozzles to reduce potential for damage during installation.
4. Field-Applied Insulation:
 - a. Components that are not factory insulated are to be field insulated to comply with requirements indicated.
 - b. Manufacturer must be responsible for chiller insulation whether factory or field installed, to ensure manufacturer is the single point of responsibility for chillers.
 - c. Manufacturer factory-authorized service representative is to instruct and supervise installation of field-applied insulation.
 - d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

J. Electrical:

1. Factory installed and wired, and functionally tested at factory before shipment.
2. Single-point, field-power connection to **[fused disconnect switch] [nonfused disconnect switch] [circuit breaker]**. Minimum SCCR according to UL 508 is to be as required by electrical power distribution system, but not less than **[42,000] [65,000] [100,000] <Insert value> A**.
 - a. Branch power circuit to each motor, electric heater, dedicated electrical load, and control, with **[circuit breaker] [or] [disconnect switch]** having SCCR to match main disconnecting means.
 - 1) NEMA KS 1, heavy-duty fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - 2) NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.
 - b. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable-frequency controller for each variable-speed motor furnished.
 - c. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Factory-installed wiring located outside of enclosures is to be installed in metal raceway. Provide terminal connections with not more than a 24-inch (610-mm) length of **[liquidtight] [flexible metallic] [liquidtight or flexible metallic]** conduit.

5. Factory install and wire capacitor bank for the purpose of power factor correction to **[0.95]** **<Insert value>** at **[full load]** **[all operating conditions]**.
 - a. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as that for motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
 - b. Capacitors are to be of non-PCB dielectric fluid, metallized electrode design, with low loss with low-temperature rise. Indicate kVAR ratings and do not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
 - c. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.
 - d. Provide a ground terminal and a terminal block or individual connectors for phase connection.

K. Motor Controller:

1. Enclosure: **[Factory installed, unit mounted]** **[Factory furnished, field mounted]**, **[NEMA 250]** **[NEMA ICS 6]**, **[Type 1]** **[Type 4]** **[Type 4X]** **[Type 12]** **<Insert type>**, with hinged full-front access door **[with lock and key or padlock and key]**.
2. Control Circuit: Obtained from **[integral control power transformer]** **<Insert source of control power>** with a control power **[transformer]** **[source]** of enough capacity to operate connected control devices.
3. Size overload relay in accordance with UL 1995 or provide as integral component of chiller control microprocessor.
4. Across-the-Line Controller: NEMA ICS 2, Class A, full voltage, nonreversing; include isolation switch and current-limiting fuses.
5. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition.
6. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition; include isolation switch and current-limiting fuses.
7. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.
 - a. Include surge suppressor in solid-state power circuits to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 - b. Visual indication of motor and control status, including the following conditions:
 - 1) Controller on.
 - 2) Overload trip.
 - 3) Loss of phase.
 - 4) Starter fault.
8. Accessories: Factory install devices in controller enclosure unless otherwise indicated.
 - a. Externally Operated~~ed~~, **[Door-Interlocked]** Disconnect: **[Fused disconnect switch]** **[Nonfused disconnect switch]** **[Circuit breaker]**. SCCR according to UL 508 is to be as required by electrical power distribution system, but not less than **[42,000]** **[65,000]** **[100,000]** **<Insert value>** A.
 - b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
 - c. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
 - d. Control Relays: Time-delay relays.
 - e. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
 - f. Number-of-Starts Counter: Numerical readout on face of enclosure.

- g. Meters: Panel type, [2-1/2 inches (64 mm)] [4-1/4 inches (108 mm)] with [90] [120] [270]-degree scale and [1] [2] percent accuracy. Where indicated, provide transfer device with an off position. Meters indicate the following:
 - 1) Ammeter: Output current for each phase, with current sensors rated to suit application.
 - 2) Voltmeter: Output voltage for each phase.
 - 3) Frequency Meter: Output frequency.
 - 4) Real-time clock with current time and date.
 - 5) Total run time.
 - 6) <Insert features>.
 - h. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1) Selectable, digital display of the following:
 - a) Phase Currents, Each Phase: Plus or minus 1 percent.
 - b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d) Three-Phase Real Power: Plus or minus 2 percent.
 - e) Three-Phase Reactive Power: Plus or minus 2 percent.
 - f) Power Factor: Plus or minus 2 percent.
 - g) Frequency: Plus or minus 0.5 percent.
 - h) Integrated Demand with Demand Interval Selectable from Five to 60 Minutes: Plus or minus 2 percent.
 - i) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
 - 2) Mounting: Display and control unit flush or semirecessed in instrument compartment door.
 - i. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
 - j. Power Protection: Chiller must shut down within six cycles of power interruption.
- L. Variable-Frequency Controller:
- 1. Motor controller is to be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
 - 2. Description: NEMA ICS 2; listed and labeled according to UL 508 as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
 - 3. Enclosure: Unit mounted, NEMA 250, [Type 1] [Type 4] [Type 4x] [Type 12], with hinged full-front access door with lock and key.
 - 4. Integral Disconnecting Means: [Door-interlocked,]NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum SCCR according to UL 508 is to be as required by electrical power distribution system, but not less than [42,000] [65,000] [100,000] <Insert value> A.
 - 5. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors; suitable for variable torque loads.

6. Controller is to consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
 - a. Rectifier Section: Full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier is to be insensitive to phase rotation of the ac line.
 - b. Regulator: Full digital control of frequency and voltage.
 - c. Inverter Section: Change fixed dc voltage to variable-frequency, variable ac voltage for application to a squirrel-cage motor. Inverter is to produce a sine-coded, PWM output waveform and conduct no RFI back to the input power supply.
7. Output Rating: Three phase, with voltage proportional to frequency throughout voltage range.
8. Operating Requirements:
 - a. Input AC Voltage Tolerance: **[460-V ac, plus 10 percent or 506 V maximum]** **<Insert voltage and tolerance>**.
 - b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
 - c. Capable of driving full load, without derating, under the following conditions:
 - 1) Ambient Temperature: **[Zero]** **<Insert number>** to **[40] [50]** **<Insert number>** deg C.
 - 2) Relative Humidity: Up to **[90] [95]** **<Insert number>** percent (noncondensing).
 - 3) Altitude: Up to **[3300 feet (1005 m)] [6600 feet (2010 m)]** **<Insert value>**.
 - d. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - e. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter; 98 percent with harmonic filter.
 - f. Overload Capability: 1.05 times the full-load current for seven seconds.
 - g. Starting Torque: As required by compressor-drive assembly.
 - h. Speed Regulation: Plus or minus 1 percent.
 - i. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
 - j. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller is to not operate continuously.
 - k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.
9. Internal Adjustability Capabilities: Integral to controller or through chiller control panel.
 - a. Minimum Output Frequency: 6 Hz.
 - b. Maximum Output Frequency: 60 Hz.
 - c. Acceleration: Two seconds to a minimum of 60 seconds.
 - d. Deceleration: Two seconds to a minimum of 60 seconds.
 - e. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.
10. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions must not result in component failure or the need for replacement:
 - a. Overtemperature.
 - b. Short circuit at controller output.
 - c. Ground fault at controller output. Variable-frequency controller is to be able to start a grounded motor.
 - d. Open circuit at controller output.
 - e. Input undervoltage.

- f. Input overvoltage.
 - g. Loss of input phase.
 - h. Reverse phase.
 - i. AC line switching transients.
 - j. Instantaneous overload, line to line or line to ground.
 - k. Sustained overload exceeding 100 percent of controller-rated current.
 - l. Starting a rotating motor.
- 11. Motor Protection: Controller is to protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
- 12. Automatic Reset and Restart:
 - a. Capable of five restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
 - b. Controller is to be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.
- 13. Visual Indication: On face of controller enclosure or chiller control enclosure. indicating the following conditions:
 - a. Power on.
 - b. Run.
 - c. Overvoltage.
 - d. Line fault.
 - e. Overcurrent.
 - f. External fault.
 - g. Motor speed (percent).
 - h. Fault or alarm status (code).
 - i. DC-link voltage.
 - j. Motor output voltage.
 - k. Input kilovolt amperes.
 - l. Total power factor.
 - m. Input kilowatts.
 - n. Input kilowatt-hours.
 - o. Three-phase input voltage.
 - p. Three-phase output voltage.
 - q. Three-phase input current.
 - r. Three-phase output current.
 - s. Three-phase input voltage THD.
 - t. Three-phase input current THD.
 - u. Output frequency (Hertz).
 - v. Elapsed operating time (hours).
 - w. Diagnostic and service parameters.
- 14. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.
- 15. Control Signal Interface:
 - a. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.
 - b. Manufacturer has option to incorporate control signal interface into chiller control panel.
- 16. Active Harmonic Distortion Filter:
 - a. Factory mounted and wired to limit total voltage and current distortion to [5] **<Insert number>** percent.

- b. Factory mounted and wired to limit total demand distortion (TDD) to **[5]** **<Insert number>** percent of unit input.
- 17. Input Line Conditioning: **<Insert requirements>**.
- 18. Cooling: **[Air]** **[Refrigerant]** **[Water]** **[Air, refrigerant, or water]** cooled.
- M. Accessory Control Relays:
 - 1. Control Relays: Auxiliary and adjustable time-delay relays.
 - 2. Devices are to be factory installed in controller enclosure unless otherwise indicated.
- N. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.
- O. Controls:
 - 1. Description: Standalone and microprocessor based, with all memory stored in nonvolatile memory, so that reprogramming is not required on loss of electrical power.
 - 2. Enclosure: Unit mounted, NEMA 250, **[Type 1]** **[Type 4]** **[Type 4x]** **[Type 12]** **<Insert type>**, hinged or lockable, factory wired with a single-point, with field-power connection and a separate control circuit.
 - 3. House factory-installed wiring outside of enclosures in a NFPA 70-approved raceway.**[Make terminal connections with liquidtight or flexible metallic conduit.]**
 - 4. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:
 - a. Date and time.
 - b. Operating or alarm status.
 - c. Fault history with not less than last 10 faults displayed.
 - d. Set points of controllable parameters.
 - e. Trend data.
 - f. Operating hours.
 - g. Number of chiller starts.
 - h. Outdoor-air temperature or space temperature if required for chilled-water reset.
 - i. Entering- and leaving-fluid temperatures of evaporator and condenser.
 - j. Difference in fluid temperatures of evaporator and condenser.
 - k. Fluid flow of evaporator and condenser.
 - l. Fluid-pressure drop of evaporator and condenser.
 - m. Refrigerant pressures in evaporator and condenser.
 - n. Refrigerant saturation temperature in evaporator and condenser shell.
 - o. Compressor refrigerant suction and discharge temperature.
 - p. Compressor bearing temperature.
 - q. Motor bearing temperature.
 - r. Motor winding temperature.
 - s. Oil temperature.
 - t. Oil discharge pressure.
 - u. Phase current.
 - v. Percentage of motor-rated load amperage.
 - w. Phase voltage.
 - x. Demand power (kilowatts).
 - y. Energy use (kilowatt-hours).
 - z. Power factor.

- aa. For chillers equipped with variable-frequency controllers and harmonic filters, include the following:
 - bb. Output voltage and frequency.
 - cc. Voltage THD for each phase.
 - dd. Supply current TDD for each phase.
 - ee. Inlet vane position.
 - ff. Controller internal ambient temperature.
 - gg. Heatsink temperature.
 - hh. Purge suction temperature if purge system is provided.
 - ii. Purge elapsed time if purge system is provided.
 - jj. **<Insert status display items>**.
- 5. Control Functions:
 - a. Manual or automatic startup and shutdown time schedule.
 - b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator-fluid temperature is to be reset based on **[return-water]** **[outdoor-air]** **[space]** temperature.
 - c. Current limit and demand limit.
 - d. Condenser-fluid temperature.
 - e. External chiller emergency stop.
 - f. Variable evaporator flow.
 - g. Thermal storage.
 - h. Heat reclaim.
 - i. **<Insert control functions>**.
- 6. Manually Reset Safety Controls: The following conditions are to shut down chiller and require manual reset:
 - a. Low evaporator **[pressure]** **[temperature]** **[pressure or temperature]**; high condenser pressure.
 - b. Low evaporator-fluid temperature.
 - c. Low oil differential pressure.
 - d. High or low oil pressure.
 - e. High oil temperature.
 - f. High compressor-discharge temperature.
 - g. Loss of condenser-fluid flow.
 - h. Loss of evaporator-fluid flow.
 - i. Motor overcurrent.
 - j. Motor overvoltage.
 - k. Motor undervoltage.
 - l. Motor phase reversal.
 - m. Motor phase failure.
 - n. Sensor- or detection-circuit fault.
 - o. Processor communication loss.
 - p. Motor controller fault.
 - q. Extended compressor surge.
 - r. Excessive air-leakage detection for chillers using R-514A or R-1233zd(E) refrigerant.
 - s. **<Insert manually reset safety controls>**.
- 7. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
- 8. 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.

9. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
10. Communication Port: RS-232 port, USB 2.0 port or higher, or equivalent connection capable of connecting a printer **[and a notebook computer]**.
11. **[BAS] [DDC System]** Interface: Factory install hardware and software to enable system to monitor, control, and display chiller status and alarms.
 - a. Hardwired I/O Points:
 - 1) Monitoring: On-off status, **[common trouble alarm] [electrical power demand (kilowatts)] [electrical power consumption (kilowatt-hours)] [power factor] <Insert monitoring point>**.
 - 2) Control: On-off operation, **[chilled-water, discharge temperature set-point adjustment] [electrical power demand limit] <Insert control point>**.
 - b. Communication Interface: **[ASHRAE 135 (BACnet)] [LonTalk] [Modbus] [Industry-accepted, open-protocol] <Insert type of interface>** communication interface is to enable control system operator to remotely control and monitor the chiller from an operator workstation.
 - 1) Control features and monitoring points displayed locally at chiller control panel are to be available through the control system, including, at a minimum, the following:
 - a) Start-stop command from remote source.
 - b) Unit control source, local, analog, digital or modem.
 - c) Chiller control panel start-stop.
 - d) Accumulated operating hours.
 - e) Accumulated starts.
 - f) Compressor motor status.
 - g) Unit operation code.
 - h) Unit safety fault code.
 - i) Unit cycling fault code.
 - j) Chilled-water pump status.
 - k) Chilled-water flow proof.
 - l) Chilled-water entering temperature.
 - m) Chilled-water leaving temperature.
 - n) Chilled-water leaving temperature set-point adjustment from remote source.
 - o) Condenser(s) water entering temperature.
 - p) Condenser(s) water leaving temperature.
 - q) Evaporator refrigerant pressure.
 - r) Condenser(s) refrigerant pressure.
 - s) Evaporator refrigerant saturation temperature.
 - t) Condenser(s) refrigerant saturation temperature.
 - u) Refrigerant discharge temperature.
 - v) Refrigerant level.
 - w) Refrigerant liquid level set point.
 - x) Oil pressure differential.
 - y) Oil sump pressure.
 - z) Oil pump pressure.
 - aa) Oil sump temperature.
 - bb) High-speed thrust bearing proximity position.
 - cc) High-speed thrust bearing proximity reference.
 - dd) Motor current percent of full-load amps.
 - ee) Motor current Phase A.

- ff) Motor current Phase B.
- gg) Motor current Phase C.
- hh) Motor current set-point adjustment from remote source.
- ii) Motor bearing shaft end vibration.
- jj) Motor bearing opposite shaft end vibration.
- kk) Motor bearing shaft end temperature.
- ll) Motor bearing opposite shaft end temperature.
- mm) Motor average winding temperature.
- nn) Variable-frequency controller selection, auto or fixed.
- oo) Variable-frequency controller output voltage.
- pp) Variable-frequency controller input power, rate.
- qq) Variable-frequency controller input power, consumption.
- rr) Variable-frequency controller DC bus voltage.
- ss) Variable-frequency controller inverter link current.
- tt) Variable-frequency controller output frequency.
- uu) Variable-frequency controller internal ambient temperature.
- vv) Variable-frequency controller converter heatsink temperature.
- ww) Variable-frequency controller harmonic filter installed, true or false.
- xx) Harmonic Filter THD at maximum voltage, percent.
- yy) Harmonic filter total demand distortion at maximum current, percent.
- zz) Harmonic filter total supply kVA.
- aaa) Anti-recycle time remaining.
- bbb) Liquid line solenoid.
- ccc) Pre-rotation vanes position.
- ddd) Adaptive capacity control valve surge map installed, true or false.
- eee) Adaptive capacity control new surge point, true or false.
- fff) Adaptive capacity control surge type, pressure differential or current.
- ggg) Adaptive capacity control surge count.
- hhh) Adaptive capacity control PRV position.
- iii) Adaptive capacity control output frequency.
- jjj) **<Insert point>.**

12. Quick-Start Feature:

- a. Automatically restore chiller operation up to **[100] <Insert number>** percent capacity within **[three] [five] <Insert number>** minutes after a **[15] <Insert number>** -second power interruption.
- b. Quick-start feature is to ensure guide vanes remain open following a power interruption event and quick ramp-up speed logic is employed to facilitate shortest time to deliver chilled water at set-point temperature.
- c. Chiller manufacturer is to provide integral UPS unit(s) with chiller controls if required to keep chiller integral controls operational to comply with requirement.
- d. Chiller manufacturer is to demonstrate chiller start time with the quick-start feature enabled while simulating power fault, power service return, restart time, and capacity control, to produce desired chilled-water temperature at load indicated.

P. Finish:

- 1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
 - a. Provide at least one coat of primer with a total dry film thickness of at least **[1.5 mils (0.03 mm)] [2 mils (0.05 mm)] <Insert thickness>**.
 - b. Provide at least **[one coat] [two coats]** of **[alkyd-modified, vinyl enamel] [epoxy] [polyurethane]** finish with a total dry film thickness of at least **[2 mils (0.05 mm)] [3 mils (0.08 mm)] [4 mils (0.1 mm)] <Insert thickness>**.

- c. Paint surfaces that are to be insulated before applying the insulation.
- d. Paint installed insulation to match adjacent uninsulated surfaces.
- e. Color of finish coat is to be **[manufacturer's standard]** **[custom color selected by Architect]** **<Insert color description>**.

Q. Accessories:

1. Flow Switches:

- a. Chiller manufacturer is to furnish a switch for each evaporator and **[condenser]** **[heat-reclaim condenser]** and verify field-mounting location before installation.
- b. Paddle Flow Switches:
 - 1) Vane operated to actuate a double-pole, double-throw switch, with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.
 - 2) Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120-V ac.
 - 3) Pressure rating equal to pressure rating of heat exchanger.
 - 4) Construct body and wetted parts of Type 316 stainless steel.
 - 5) House switch in a NEMA 250, **[Type 4]** **<Insert type>** enclosure constructed of die-cast aluminum.
 - 6) Vane length to suit installation.
- c. Pressure-Differential Switches:
 - 1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
 - 2) Performance: Switch is to withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
 - 3) Set Point: Screw type, field adjustable.
 - 4) Electrical Connections: Internally mounted screw-type terminal blocks.
 - 5) Switch Enclosure: NEMA 250, **[Type 4]** **<Insert type>**.
 - 6) Switch Action: Double-pole, double-throw switch, with one pole field wired to the chiller control panel and the other pole field wired to the DDC system for HVAC.

2. Vibration Isolation:

- a. Chiller manufacturer is to furnish vibration isolation for each chiller.
- b. Neoprene Pad:
 - 1) Two layers of 0.375-inch- (10-mm-) thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gauge, stainless steel plate.
 - 2) Fabricate pads from 40- to **[50] [60] <Insert number>**-durometer neoprene.
 - 3) Provide stainless steel square bearing plate to load the pad uniformly between 20 and 40 psig (138 and 276 kPa) with a 0.12- to 0.16-inch (3- to 4-mm) deflection.
- c. Spring Isolator:
 - 1) Stable in operation and designed for not less than 30 percent reserve deflection beyond actual operating conditions.
 - 2) Design isolators so that the Kx/Ky ratio will be 1.0 or more for stability.
 - 3) Provide PVC or neoprene-coated springs and hot-dip, galvanized-steel components. Provide aluminum components that are etched and painted. Provide nuts, bolts, and washers that are zinc electroplated.

- 4) Isolators are to be adjustable and with an open spring, having one or more coil springs attached to a top compression plate and a baseplate.
- 5) An elastomeric pad with a minimum thickness of 0.25 inch (6 mm) is to be bonded to the baseplate.
- 6) Spring assembly is to be removable and fit within a welded-steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation.
- 7) Isolated restraining bolts are to not be engaged during normal operation and are to connect the top plate and lower housing to prevent the isolated equipment from rising when drained of fluid.
- 8) Select isolators for a nominal **[1-inch (25-mm)] [2-inch (50-mm)] <Insert dimension>** deflection.
- 9) Integrate seismic restraints in applications that require seismic requirements.

3. Sound Barrier:

- a. Provide sound barrier only if required to comply with sound requirements indicated.
- b. Furnish removable and reusable sound-barrier covers over the compressor housing, hermetic motor, compressor suction and discharge piping, and condenser shell.
- c. Provide for repeated installation and removal without use of tape or caulk.
- d. Inner and outer cover is to consist of a PTFE-impregnated fiberglass cloth enclosing heavy-density, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.
- e. Covers are to be double sewn and lock stitched, with edges folded and sewn so no raw cut edges are exposed.
- f. Form covers around control devices, gauges, conduit, piping, and supports without degrading sound-barrier performance.
- g. Continuously lap all exposed seams at least 2 inches (50 mm) for better sound containment.
- h. Permanently label each section of cover to indicate its location, description, size, and number sequence.
- i. Randomly place stainless steel quilting pins to prevent covers from shifting and sagging.

2.4 HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

- A. Description: Factory provided by chiller manufacturer, field-installed, brush-cleaning system on each chiller **[condenser] <Insert heat exchanger>** for tube cleaning and improved heat transfer.
- B. System is to prevent tube fouling at or below design conditions without interrupting normal equipment operation.
- C. System is to consist of a brush inserted into each tube and a catch basket attached to each end of the tube. A four-way valve is to operate to reverse the direction of water flow, to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator is to be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle is to be set up to match Project requirements.
- D. Components:
 1. Brush: Each brush is to have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube is not to exceed 0.025 inch (0.6 mm).

2. Basket: Single-piece polypropylene basket with neck OD to press fit ID of tube. Design is to provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.
3. Four-Way Valve:
 - a. Construct valve body of carbon steel, with internal sealing parts of hard rubber and Type 304 stainless steel.
 - b. Configure valve with parallel flow connections to minimize field installation of piping.
 - c. Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to that of condenser.
 - d. Provide flanged pipe connections.
 - e. Valve manufacturer is to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operating conditions of maximum differential pressure.
 - f. Hydrostatically test to 1.5 times the design working pressure.
 - g. Design the valve to cause no more than 0.5-psig (3-kPa) pressure drop at design flow conditions.
 - h. Provide valve with valve-mounted indicating/warning light that will light before the valve begins rotation.
 - i. Valve Actuator, Electric: Mount electric actuator to operate valve.
 - j. Valve Actuator, Pneumatic: Mount pneumatic piston-type actuator to operate valve. Actuator is to be suitable for operation using field-supplied air pressure.
 - k. Position Switches: Factory mount microswitches on the valve to indicate the complete turn of valve in both normal and reverse flow.
4. Control Panel: Factory or field mount a control panel on chiller. Control panel is to include the following features:
 - a. NEMA 250, **[Type 1]** **[Type 4]** **[Type 4x]** **[Type 12]** enclosure.
 - b. Timer to automatically initiate the cleaning cycle over a 24-hour period.
 - c. Manual override of preset cleaning cycle.
 - d. Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction," indicating a slow turn or incomplete valve turn.
 - e. For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
 - f. Flow switch bypass.
 - g. Unloading signal to chiller.

2.5 SOURCE QUALITY CONTROL

- A. AHRI Certification: Certify chiller in accordance with "Water-Cooled Chiller Certification Program."
- B. Performance Tolerance: Comply with the following in lieu of AHRI 550/590 (AHRI 551/591):
 1. Allowable Capacity Tolerance: **[Zero]** **<Insert number>** percent.
 2. Allowable Full-Load Energy Efficiency Tolerance: **[Zero]** **<Insert number>** percent.
 3. Allowable Part-Load Energy Efficiency Tolerance: **[Zero]** **<Insert number>** percent.
- C. Perform functional **[run]** tests of chillers before shipping.
- D. Factory Performance Testing:
 1. Factory performance test chillers, before shipping, in accordance with AHRI 550/590 (AHRI 551/591).
 2. Test the following conditions:
 - a. Design conditions indicated.

- b. Reduction in capacity from design to minimum load in steps of [10] [25] [33] <Insert number> with condenser fluid at design conditions.
 - c. Reduction in capacity from design to minimum load in steps of [10] [25] [33] <Insert number> with varying entering condenser-fluid temperature from design to minimum conditions in [5 deg F (3 deg C)] <Insert temperature> increments.
 - d. At [one] [two] [three] [four] [five] [10] <Insert number> point(s) of varying part-load performance to be selected by Owner at time of test.
 3. Allow [Owner] <Insert entity> access to place where chillers are being tested. Notify Owner in writing at least [30] <Insert number> days in advance of testing.
 4. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- E. Factory Sound Testing:
 1. For chillers located indoors, rate sound power level in accordance with AHRI 575.
 2. Factory sound test chillers, before shipping, in accordance with AHRI 575.
 3. Test the following conditions:
 - a. Design conditions indicated.
 - b. Chiller operating at calculated worst-case sound condition.
 - c. At [one] [two] [three] [four] [five] <Insert number> point(s) of varying part-load performance to be selected by Owner at time of test.
 4. Allow [Owner] <Insert entity> access to place where chillers are being tested. Notify Owner in writing at least [30] <Insert number> days in advance of testing.
 5. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- F. Factory test and inspect evaporator [and condenser] [, condenser, and heat-reclaim condenser] according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- G. Factory test and inspect evaporator [and condenser] [, condenser and heat-reclaim condenser] according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test fluid side of heat exchangers, including water boxes, to 1.5 times the rated pressure. Pressure proof test refrigerant side of heat exchangers to a minimum of 45 psig (310 kPa). Vacuum and pressure test for leaks.
- H. Eddy Current Testing:
 1. Perform factory testing of evaporator and condenser tubes of each chiller to ensure tube quality and longevity.
 2. Submit test report, including, at a minimum:
 - a. List of equipment used and equipment settings.
 - b. Test data reports and accompanying strip charts of calibrations.
 - c. Identify tubes with significant defects and typical indications.
 - d. Statistical summary of defect indications.
 - e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.
 - f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.
- I. Owner Travel Expenses:
 1. Include cost associated with Owner travel expenses to witness factory testing. Total value attributed to travel expenses is to be clearly indicated.
 2. Expenses are to include roundtrip coach airfare, out-of-town hotel accommodations, out-of-town meals (breakfast, lunch, and dinner), out-of-town ground transportation, and all associated taxes and fees.

3. Exclude other incidental expenses not indicated.
4. Include travel expenses for [one] [two] <Insert number> Owner representative(s) with origin of <Insert city, state, country>.

PART 3 - EXECUTION – NOT USED

END OF SECTION 236416

SECTION 236423.13 - AIR-COOLED, SCROLL WATER CHILLERS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
- C. Performance Tolerance: Comply with the following in lieu of AHRI 550/590:
 - 1. Allowable Capacity Tolerance: **[Zero]** <Insert number> percent.
 - 2. Allowable Full-Load Energy Efficiency Tolerance: **[Zero]** <Insert number> percent.
 - 3. Allowable Part-Load Energy Efficiency Tolerance: **[Zero]** <Insert number> percent.
- D. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.
- E. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
- F. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- G. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- H. Comply with NFPA 70.
- I. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.
- J. Operation Following Loss of Normal Power:
 - 1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
 - 2. See drawings for equipment served by backup power systems.
 - 3. Provide means and methods required to satisfy requirement even if not explicitly indicated.
- K. Outdoor Installations:
 - 1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a **25**-year period with minimal degradation due to exposure to outdoor ambient conditions.
 - 2. Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past **30**-year period.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation; a unit of United Technologies Corp.
 2. Daikin Applied.
 3. Trane.
 4. YORK; a Johnson Controls company.
 5. <Insert manufacturer's name>.

2.3 MANUFACTURED UNITS

- A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.
- B. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.
- C. Sound-reduction package shall have the following:
1. Acoustic enclosure around compressors.
 2. Reduced-speed fans with acoustic treatment.
 3. Designed to reduce sound level without affecting performance.
- D. Security Package: Security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.

2.4 CABINET

- A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
- B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
- C. Casing: Galvanized steel.
- D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B117.

2.5 COMPRESSOR-DRIVE ASSEMBLIES

- A. Compressors:
1. Description: Positive-displacement direct drive with hermetically sealed casing.
 2. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
 3. Capacity Control: On-off compressor cycling, plus hot-gas bypass.
 - a. Digital compressor unloading is an acceptable alternative to achieve capacity control.
 4. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.
 - a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.

5. Vibration Isolation: Mount individual compressors on vibration isolators.
 - a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

B. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

C. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

2.6 REFRIGERATION

- A. Refrigerant: R-410A. Classified as Safety Group A1 according to ASHRAE 34.
- B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- C. Refrigerant Circuit: Each circuit shall include **[an electronic] [or] [a thermal]**-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
- D. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
 1. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in each circuit in lieu of each compressor.
- E. Pressure Relief Device:
 1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
 3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

2.7 EVAPORATOR

- A. Brazed-plate or shell-and-tube design, as indicated.
- B. Shell and Tube:
 1. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
 2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
 3. Shell Material: Carbon steel.
 4. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
 5. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.**[Furnish flange adapters to mate to flanged piping.]**
 6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

C. Brazed Plate:

1. Direct-expansion, single-pass, brazed-plate design.
2. Type **[304] [or] [316]** stainless-steel construction.
3. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.
4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping. **[Furnish flange adapters to mate to flanged piping.]**
5. Inlet Strainer: Factory-furnished, **[20] [or] [40]** **<Insert value>**-mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.

D. Flow Switch: Factory-furnished **[and -installed,]** **[thermal-type]** flow switch wired to chiller operating controls.

E. Remote-Mounting Kit: Designed for remote field mounting where indicated. Provide kit for field installation.

2.8 AIR-COOLED CONDENSER

A. Coil(s) with integral subcooling on each circuit.

B. Copper Tube with Plate Fin Coils:

1. Construct coils of copper tubes mechanically bonded to **[aluminum] [copper]** fins.
2. Coating: **[None] [Corrosion resistant]**.

C. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

D. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

E. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.

1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

F. Fan Guards: Removable steel safety guards with corrosion-resistant **[PVC]** coating.

2.9 HEAT RECOVERY CONDENSER

A. Brazed plate, or shell and tube; as indicated, capable of **[partial]** heat recovery.

B. Shell and Tube:

1. Description: Shell-and-tube design with refrigerant flowing through the shell and fluid flowing through the tubes within the shell.
2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
3. Shell Material: Carbon steel.
4. Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with mechanical-coupling end connections for connection to field piping.
5. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
6. Provide each condenser circuit with a pressure relief device, purge cock, and liquid-line shutoff valve.
7. Provide each condenser with vent and drain.

C. Brazed Plate:

1. Type 316 stainless-steel construction.
2. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.
3. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
4. Inlet Strainer: Factory-furnished, **[20] [or] [40] <Insert value>**-mesh strainer for field installation in supply piping to condenser. Manufacturer has option to factory install strainer.

2.10 CHILLED-WATER HYDRONIC PACKAGE

A. Factory-furnished **[and -installed]** hydronic package consisting of the following:

1. Pumps: Single or dual pumps with capacity, as indicated.
 - a. **[Vertical in-line] <Insert type>** type, single-stage design, serviceable without disturbing piping connections.
 - b. Cast-iron, ductile-iron, bronze, or stainless-steel body.
 - c. Bronze or stainless-steel impeller keyed to shaft and secured with screw.
 - d. Premium efficient motor with TEFC motor enclosure.
 - e. Dual pump packages to provide for servicing and replacement of failed pump with other pump operating.
 - f. Variable-speed pumps with variable-frequency controllers integral to pump motor or provided with chiller electrical package.
 2. Expansion Tank: **[Replaceable]** bladder type.
 3. Storage Tank: Insulated carbon-steel tank with **[internal baffles,]** drain and vent connections; with capacity indicated.
 4. Piping: **[Copper tube] [or] [carbon-steel pipe]**.
 5. Strainers: Y-type at suction side of each pump.
 6. Valves:
 - a. Ball- or butterfly-style valves for isolation and balancing.
 - b. Check valve on each pump discharge for dual pump packages.
 - c. Drain valves to be positioned to drain isolated sections of pipe and equipment.
 - d. Option to use combination valves.
 7. Hydronic Specialties:
 - a. Air Vents: **[Automatic] [or] [manual]** air vents located and arranged to vent air from high points and locations capable of trapping air.
 - b. Test Plugs: Located to measure pressure difference across each pump and strainer.
- B. Hydronic package rated for same pressure as evaporator.
- C. Pressure and leak tested before apply insulation.
- D. Insulation on hydronic package shall match evaporator.
- E. Controls:
1. Lead/lag operation for dual pump packages.
 2. Controlled to automatically equalize run time.
 3. Control of variable-speed pumps.
 4. Integral to chiller control package.
 5. Remotely controlled through field interface with building controls.

2.11 INSULATION

- A. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials.
 - 1. Thickness: **[3/4 inch (19 mm)] [1-1/2 inches (38 mm)] <Insert dimension>**.
- B. Adhesive: As recommended by insulation manufacturer.
- C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
 - 1. Apply adhesive to 100 percent of insulation contact surface.
 - 2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
 - 3. Seal seams and joints to provide a vapor barrier.
 - 4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
 - 5. Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.
 - 6. Field-Applied Insulation:
 - a. Components that are not factory insulated shall be field insulated to comply with requirements indicated.
 - b. Manufacturer shall be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.
 - c. Manufacturer's factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
 - d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

2.12 ELECTRICAL

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
- C. House in a unit-mounted, NEMA 250, **[Type 3R] <Insert type>** enclosure with hinged access door with lock and key or padlock and key.
- D. Wiring shall be numbered and color-coded to match wiring diagram.
- E. Factory wiring shall be located outside of an enclosure in a **[metal]** raceway. Terminal connections shall be made with not more than a **24-inch (610-mm)** length of **[liquidtight] [or] [flexible metallic]** conduit.
- F. Field power interface shall be to **[wire lugs] [NEMA KS 1, heavy-duty, nonfused disconnect switch] [circuit breaker]**. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than **[42,000] [65,000] [100,000] <Insert value> A**.
- G. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
 - 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - 2. NEMA KS 1, heavy-duty, nonfusible switch.

3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- H. Each motor shall have overcurrent protection.
- I. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
- J. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
- K. Power Factor Correction: Capacitors to correct power factor to **[0.90] [0.95] <Insert value>** at full load.
- L. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- M. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.
- N. Service Receptacle:
 1. Unit-mounted, 120-V GFI duplex receptacle.
 2. Power receptacle from chiller internal electrical power wiring.
- O. Indicate the following for water chiller electrical power supply:
 1. Current, phase to phase, for all three phases.
 2. Voltage, phase to phase and phase to neutral for all three phases.
 3. Three-phase real power (kilowatts).
 4. Three-phase reactive power (kilovolt amperes reactive).
 5. Power factor.
 6. Running log of total power versus time (kilowatt hours).
 7. Fault log, with time and date of each.
 8. **<Insert features>**.

2.13 CONTROLS

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
- C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
- D. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:
 1. Date and time.
 2. Operating or alarm status.
 3. Operating hours.
 4. Outside-air temperature if required for chilled-water reset.
 5. Temperature and pressure of operating set points.
 6. Chilled-water entering and leaving temperatures.
 7. Refrigerant pressures in evaporator and condenser.
 8. Saturation temperature in evaporator and condenser.
 9. No cooling load condition.
 10. Elapsed time meter (compressor run status).
 11. Pump status.
 12. Antirecycling timer status.
 13. Percent of maximum motor amperage.

14. Current-limit set point.
 15. Number of compressor starts.
 16. Alarm history with retention of operational data before unit shutdown.
 17. Superheat.
 18. **<Insert items>**.
- E. Control Functions:
1. Manual or automatic startup and shutdown time schedule.
 2. Capacity control based on evaporator leaving-fluid temperature.
 3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
 4. Chilled-water entering and leaving temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on **[return-water] [outside-air] [space] <Insert variable>** temperature.
 5. Current limit and demand limit.
 6. Condenser-water temperature.
 7. External water chiller emergency stop.
 8. Antirecycling timer.
 9. Automatic lead-lag switching.
 10. Ice-building mode.
 11. **<Insert functions>**.
- F. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
1. Low evaporator pressure or high condenser pressure.
 2. Low chilled-water temperature.
 3. Refrigerant high pressure.
 4. High or low oil pressure.
 5. High oil temperature.
 6. Loss of chilled-water flow.
 7. Loss of condenser-water flow.
 8. Control device failure.
 9. **<Insert items>**.
- G. **[BAS] [DDC]** System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.
1. Hardwired I/O Points:
 - a. Monitoring: On/off status, **[common trouble alarm] [electrical power demand (kilowatts)] [electrical power consumption (kilowatt hours)] <Insert monitoring point>**.
 - b. Control: On/off operation, **[chilled-water discharge temperature set-point adjustment] [electrical power demand limit] <Insert control point>**.
 2. Communication Interface: **[ASHRAE 135 (BACnet)] [LonTalk] [Modbus] [Industry-accepted open-protocol] <Insert type of interface>** communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.
- H. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. **[Make terminal connections with liquidtight or flexible metallic conduit.]**

2.14 ACCESSORIES

- A. Factory-furnished [neoprene] [or] [spring] isolators [with seismic restraints] for field installation.
 - 1. Spring Deflection: [1 inch (25 mm)] [2 inches (50 mm)] <Insert inches (mm)>.

2.15 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.
- E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
- F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [3000] <Insert time>-hour salt-spray test according to ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
 - c. ASTM B3359 for cross hatch adhesion of 5B.
 - 2. Application: [Immersion] [Spray].
 - 3. Thickness: [1 mil (0.025 mm)] <Insert value>.
 - 4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.16 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory performance test water chillers, before shipping, according to AHRI 550/590.
 - 1. Test the following conditions:
 - a. Design conditions indicated.
 - b. AHRI 550/590 part-load points.
 - c. <Insert test points>.
 - 2. Allow [Owner] <Insert entity> access to place where water chillers are being tested. Notify [Owner] <Insert entity> [14] [30] <Insert number> days in advance of testing.
- C. Factory test and inspect evaporator [and water-cooled condenser] according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- D. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

PART 3 - EXECUTION – NOT USED

END OF SECTION 236423.13

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SECTION 236514.14 - OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Each Cooling Tower shall have Venturi Style Sand Filters either specified with Tower or in separate Hydronic Specialties section.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amcot Cooling Tower Corp.
 - 2. Baltimore Aircoil Company.
 - 3. EVAPCO, Inc.
 - 4. Marley Cooling Technologies; SPX Cooling Technologies.
 - 5. **<Insert manufacturer's name>.**

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cooling tower support structure[**and seismic restraints**] [**and wind restraints**], including comprehensive engineering analysis.
- B. Structural Performance: Cooling tower and support structure shall withstand the effects of loads and stresses within limits and under conditions indicated according to [ASCE/SEI 7] [the IBC] [governing codes] **<Insert requirement>.**
- C. Seismic Performance: Cooling towers 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. Component Importance Factor: [1.5] [1.0].
 - 3. Component Amplification Factor: **<Insert value>.**
 - 4. Component Response Modification Factor: **<Insert value>.**
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
- 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.
- F. Operation Following Loss of Normal Power:
 - 1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.

2. Include means and methods required to satisfy requirement even if not explicitly indicated.

G. Vibration:

1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry-standard requirements for cooling towers.
2. Critical speed shall be at least 115 percent of design speed.

2.4 DESIGN ARRANGEMENT

- A. Crossflow design with airflow from two sides and induced-draft, top-mounted axial fan and gravity distribution basin.
- B. Crossflow design with airflow from one side and induced-draft, top-mounted axial fan and gravity distribution basin.
- C. Crossflow design with airflow from one side and induced-draft, side-mounted axial fan and gravity distribution basin.

2.5 CASING AND FRAME

- A. Casing Material: **[FRP with UV inhibitors] [Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating] [Polymer-coated galvanized steel] [Stainless steel, Grade 304] [Stainless steel, Grade 316] <Insert material>.**
- B. Frame Material: **[FRP with UV inhibitors] [galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating] [polymer-coated galvanized steel] [stainless steel, Grade 304] [stainless steel, Grade 316] [or] [materials to match casing] <Insert material>.**
- C. Hardware: **[Galvanized] [or] [stainless]** steel.
- D. Joints and Seams: Sealed watertight.
- E. Welded Connections: Sealed watertight[**by continuous welds**].

2.6 COLLECTION BASIN

- A. Field-Constructed Collection Basin: Configure tower without a factory-assembled collection basin for installation and operation with a field-constructed collection basin.
- B. Factory-Assembled Collection Basin:
 1. Material: **[FRP with UV inhibitors] [Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating] [Polymer-coated galvanized steel] [Stainless steel, Grade 304] [Stainless steel, Grade 316] <Insert material>.**
 2. Hardware: **[Galvanized] [or] [stainless]** steel.
 3. Joints and Seams: Sealed watertight.
 4. Welded Connections: Sealed watertight[**by continuous welds**].
 5. Removable[**stainless-steel**] strainer with openings smaller than nozzle orifices.
 6. Overflow and drain connections.
 7. Makeup-water connection.
 8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
 9. Removable equalization flume plate between adjacent cells of multiple-cell towers.
 10. Equalizer connection for field-installed equalizer piping configured to mate to ASME B16.5, Class 150 flange.
 11. Basin Sweeper Distribution Piping and Nozzles:

- a. Pipe Material: **[PVC] [or] [CPVC] <Insert material>**, Schedule 40 or heavier, treated with UV inhibitors and intended for continuous exposure to direct sunlight with degradation.
- b. Nozzle Material: **[Plastic] <Insert material>**.
- c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.
- d. Basin penetrations sealed watertight.
- e. Field Connections: Threaded or flanged depending on pipe size. Thread for sizes through **<Insert pipe size>** and flanged for larger sizes.

2.7 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

- A. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
- B. Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve:
 1. Enclosures: NEMA 250, **[Type 4] [Type 4X] <Insert Type>**.
 2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to **[control makeup-water valve] [control makeup-water valve and low-level alarm] [control makeup-water valve and low- and high-level alarms] [control makeup-water valve, low- and high-level alarms, and output for shutoff of pump on low level]**.
 3. Electrode Probes: Stainless steel.
 4. Water Stilling Chamber: **[Corrosion-resistant material] [FRP] [Galvanized steel] [PVC pipe] [Stainless steel, Grade 304] [Stainless steel, Grade 316] <Insert material>**.
 5. Makeup-Water Valve:
 - a. Slow closing **[with stainless-steel body]**.
 - b. Actuator controlled and powered through level controller in response to water-level set point.
 - c. Actuator Enclosure: NEMA 250, **[Type 4] [Type 4X] <Insert Type>**.
 - d. Fail Position: **[Closed] [Open] [Last]**.
 - e. Action: **[Two position] [or] [modulating]**.
 6. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.
- C. Ultrasonic Collection Basin Water-Level Controller with Makeup-Water Valve:
 1. Enclosure: NEMA 250, **[Type 4] [Type 4X] <Insert Type>**.
 2. Controller:
 - a. Ultrasonic level sensor/transmitter with local display of measured value.
 - b. Factory wired to terminal strip.
 - c. Control make-up water valve in response to water-level set point.
 - d. Adjustable level, alarm signal through relay closure **[for connection to control system]**.
 - e. Signal continuous level indication through a 4- to 20-mA signal **[for connection to control system]**.
 3. Water Stilling Chamber: **[Corrosion-resistant material] [FRP] [Galvanized steel] [PVC pipe] [Stainless steel] <Insert material>**.
 4. Makeup-Water Valve:
 - a. Slow closing **[with stainless-steel body]**.
 - b. Valve actuator controlled and powered through level controller in response to water-level set point.
 - c. Actuator Enclosure: NEMA 250, **[Type 4] [Type 4X] <Insert Type>**.
 - d. Fail Position: **[Closed] [Open] [Last]**.

e. Action: **[Two position]** **[or]** **[modulating]**.

5. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

2.8 COLLECTION BASIN HEATER

A. Electric Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, **[Type 3R]** **[Type 4]** **[Type 4X]** **<Insert Type>**.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a **[fused disconnect switch]** **[nonfused disconnect switch]** **[circuit breaker]** and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except connections to each electric basin heater shall be liquidtight conduit.
 - a. Raceway shall be corrosion-resistant **[stainless steel]** **[or]** **[PVC coated steel]**.

B. Hot-Water-Coil Heater: Manufacturer's standard heater with indicated capacity.

C. Steam-Coil Heater: Manufacturer's standard heater with indicated capacity.

D. Steam-Injector Heater: Manufacturer's standard offering heater with indicated capacity.

2.9 GRAVITY WATER DISTRIBUTION BASIN

A. Design: Non-pressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.

1. Material: **[FRP with UV inhibitors]** **[galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating]** **[polymer-coated galvanized steel]** **[or]** **[stainless steel]** **<Insert material>**.
2. Location: Over each bank of fill with easily replaceable **[plastic]** **<Insert material>** spray nozzles mounted in bottom of basin.
3. Inlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
4. Fasteners: **[Galvanized]** **[or]** **[stainless]** steel.
5. Joints and Seams: Sealed watertight.
6. Welded Connections: Sealed watertight **[by continuous welds]**.
7. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable **[corrosion-resistant]** **[stainless-steel]** hardware. Panels reinforced to accommodate service personnel walking on the panels without resulting in permanent deflection and damage.
8. Valves: Manufacturer's standard valve installed at each inlet connection and arranged to balance or shut off flow to each gravity distribution basin.
9. Single-Inlet, Field Pipe Connection: **[Galvanized-steel]** **[PVC]** pipe arranged to achieve balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the **[bottom]** **[side]** unless otherwise indicated.

2.10 FILL

- A. Materials: PVC, with maximum flame-spread index of [5] [25] <Insert value> according to ASTM E 84.
- B. Minimum Thickness: [15 mils (0.4 mm)] [20 mils (0.5 mm)] <Insert value>, before forming.
- C. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
- D. Hardware: [Galvanized] [or] [stainless] steel.

2.11 DRIFT ELIMINATORS

- A. Material: [FRP] [PVC] [FRP or PVC] <Insert material>; with maximum flame-spread index of [5] [25] <Insert value> according to ASTM E 84.
- B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
- C. Configuration: Multipass, designed and tested to reduce water carryover to [0.005] <Insert number> percent of design flow rate indicated.
- D. Location: [Integral to] [Separate and removable from] fill.
- E. Hardware: [Galvanized] [or] [stainless] steel.

2.12 AIR INLET

- A. Air-Intake Louvers:
 - 1. Material: [FRP] [PVC] [Matching casing] <Insert material>.
 - 2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
 - 3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
 - 4. Location: [Integral to] [Separate from] fill.
- B. [Removable] Air-Intake Screens:
 - 1. [Galvanized] [Polymer-coated, galvanized] [Stainless]-steel wire mesh with openings of size sufficient to not restrict airflow or impact performance.
 - 2. Segmented into manageable individual sections arranged to facilitate independent removal of each section without disturbing adjoining sections.
- C. Hardware: [Galvanized] [or] [stainless] steel.

2.13 FAN AND DRIVE ASSEMBLY

- A. Axial Fan: Balanced at the factory[after assembly].
 - 1. Blade Material: [Aluminum] [FRP] [or] [galvanized steel] <Insert material>.
 - 2. Hub Material: [Aluminum] [FRP] [or] [galvanized steel] <Insert material>.
 - 3. Blade Pitch: Field adjustable.
 - 4. Fan Shaft: [Corrosion resistant] [Stainless steel] <Insert material>.
 - 5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of [40,000] [50,000] [100,000] <Insert value> hours.
 - 6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
 - 7. Provide vibration monitors with fan assembly.

Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.

8. Provide vibration monitors with fan assembly.
- B. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.
1. Gear Drive and Coupling Service Factor: **[2.0] <Insert value>** based on motor nameplate horsepower.
 2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
 3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
 4. Operation: Able to operate both forward and in reverse. Able to operate throughout entire speed range from design speed indicated down to **[10] [20] <Insert value>** of design speed.
 5. Drive-to-Motor Connection: Close coupled to motor using a flexible coupling.
 6. Drive-to-Motor Connection: Connected to motor located outside of cooling tower casing by a full-floating drive shaft.
 7. Drive Shaft Material: **[Corrosion resistant] [Stainless steel]**, and fitted with flexible couplings on both ends.
 8. Drive Guards: Exposed shaft and couplings shall have guards according to OSHA regulations.
 9. Extend oil fill, drain, and vent to outside of cooling tower casing using **[galvanized-steel] [or] [stainless-steel]** piping. Include oil-level sight glass.
 10. Provide vibration monitors with fan assembly.
- C. Fan Motor:
1. Comply with NEMA MG 1 unless otherwise indicated.
 2. Description: NEMA MG 1, **[Design B] <Insert design>**, as required to comply with capacity and torque characteristics; medium induction motor.
 3. 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.
 4. Motor Enclosure: **[Totally enclosed] [Totally enclosed air-over (TEAO)] [Totally enclosed fan-cooled (TEFC)] [and with epoxy or polyurethane finish]**.
 5. Rotor: Random-wound, squirrel cage.
 6. Energy Efficiency: **[Comply with ASHRAE/IES 90.1] [NEMA Premium Efficient]**.
 7. Service Factor: **[1.15] <Insert value>**.
 8. Temperature Rise: **[Match] [One class lower than] <Insert requirements>** insulation rating.
 9. Insulation: **[Class F] [Class H] <Insert class>**.
 10. Variable-Speed Motors: Inverter-duty rated per NEMA MG 1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
 11. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
 - a. Internal Heater: Automatically energized when motor is de-energized.
 - b. Complying with IEEE 841.
 12. Motor Shaft Grounding: Motors shall be controlled through variable-frequency controllers with shaft grounding system to protect motor bearings from induced voltage. Drag on motor shaft due to shaft ground system shall be less than **[0.5] <Insert number>** percent of motor nameplate horsepower.
- D. Hardware: **[Galvanized] [or] [stainless]** steel.

2.14 AIR DISCHARGE

A. Low-Profile Fan Discharge Stack:

1. Manufacturer's standard low-profile design.
2. Material: **[Material to match casing] [FRP] [Galvanized steel] [Polymer-coated, galvanized steel] [Stainless steel] <Insert material>**.
3. Stack Extension: Fabricated to extend above fan deck **<Insert distance>** unless otherwise indicated.
4. Stack Termination: Wire-mesh, **[galvanized-steel] [polymer-coated, galvanized-steel] [or] [stainless-steel] <Insert material>** screens; segmented into multiple removable pie sections and complying with OSHA regulations.

B. Velocity Recovery Fan Discharge Stack:

1. Design: Tapered and expanded for velocity recovery and improved energy efficiency.
2. Material: FRP or material matching casing.
3. Stack Height: Fabricated to extend above fan deck at least **[5 feet (1.5 m)] <Insert dimension>** unless otherwise indicated.
4. Service Access: Fabricated of multiple segments to facilitate removal of fan and drive components from overhead.
5. Stack Termination: Wire-mesh, **[galvanized-steel] [polymer-coated, galvanized-steel] [or] [stainless-steel] <Insert material>** screens; segmented into multiple removable pie sections and complying with OSHA regulations.

C. Hardware: **[Galvanized] [or] [stainless]** steel.

2.15 ELECTRICAL POWER

A. Factory Furnish for Field Installation: A **[disconnect switch] [motor controller] [variable-frequency controller]** for each fan motor.

B. Factory Install: A **[disconnect switch] [motor controller] [variable-frequency controller]** for each fan motor.

1. Locate in a convenient and field-accessible location within sight of motor.
2. Installation shall comply with NFPA 70.
3. Wire, Conduit, and Enclosures:

Minimum Conduit Size: **[0.75 inch (20 mm)] <Insert size>**.

- a. Materials: Corrosion resistant**[and constructed of stainless steel or PVC coated steel]**.
- b. Motor Termination: Liquidtight conduit, not to exceed 36 inches (900 mm) long.
- c. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware**[constructed of stainless steel]**.
- d. Wire:
 - 1) Copper, rated for 600-V, solid wire for size **[No. 10 AWG] <Insert wire size>** and smaller and stranded wire for larger sizes.
 - 2) Minimum Wire Size: **[No. 12 AWG] <Insert wire size>**.
 - 3) Each circuit shall have a ground wire.
 - 4) Install wire in conduit.
- e. Boxes, Condulets, and Enclosures: NEMA 250, **[Type 3R] [Type 4] [Type 4X]**.

C. Disconnect Switches:

1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
2. Three pole, **[fused] [or] [nonfused]**.
3. 600 V rated.

4. Minimum SCCR: As required by electrical power distribution system, but not less than **[42,000] [65,000] <Insert value> A.**
5. Enclosure: NEMA 250, **[Type 3R] [Type 4] [Type 4X] [or] [Type 4X stainless steel] <Insert Type>.**
6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
9. Include a solid neutral as required by authorities having jurisdiction.
10. Disconnect switch shall have a ground lug for ground wire termination.
11. Operating handle shall be lockable in open position.
12. Horsepower rated.
13. Feed through or double lugged.

D. Motor Controllers:

1. NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller.
2. Configured for control of single- or multispeed motors as indicated.
3. Enclosure: NEMA 250, **[Type 3R] [Type 4] [Type 4X] [or] [Type 4X stainless steel] <Insert Type>**, with hinged full-front access door with lock and key.
4. Externally Operated[, **Door-Interlocked]** Disconnect: **[Fused disconnect switch] [Nonfused disconnect switch] [Circuit breaker]** with lockable handle.
5. SCCR: As required by electrical power distribution system, but not less than **[42,000] [65,000] <Insert value> A.**
6. Hand-Off-Auto Switch: Mounted on face of enclosure.
7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.
8. Control Relays: Time-delay relays.
9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
11. Number-of-Starts Counter: Numerical readout on face of enclosure.

E. Variable-Frequency Controllers:

1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.
2. Enclosure: Unit mounted, NEMA 250, **[Type 3R] [Type 4] [Type 4X] [or] [Type 4X stainless steel] <Insert Type>**, with hinged full-front access door with lock and key.
3. Externally Operated[, **Door-Interlocked]** Disconnect: **[Fused disconnect switch] [Nonfused disconnect switch] [Circuit breaker]** with lockable handle.
4. Minimum SCCR: As required by electrical power distribution system, but not less than **[42,000] [65,000] <Insert value> A.**
5. Technology: Pulse-width-modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
8. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.
9. Operating Requirements:
 - a. Input AC Voltage Tolerance: **[10] <Insert number> percent.**

- b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
 - c. Capable of driving full motor load, without derating.
 - d. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - e. Minimum Displacement Primary-Side Power Factor: 95 percent.
 - f. Overload Capability: 1.05 times the full-load current for 7 seconds.
 - g. Starting Torque: As required by fan and motor drive assembly.
 - h. Speed Regulation: 1 percent.
 - i. Speed Range: 10:1 speed range.
 - j. To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
 - k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.
10. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
11. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:
- a. Overtemperature.
 - b. Short circuit at controller output.
 - c. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
 - d. Open circuit at controller output.
 - e. Input undervoltage.
 - f. Input overvoltage.
 - g. Loss of input phase.
 - h. Reverse phase.
 - i. AC line switching transients.
 - j. Instantaneous overload, line to line or line to ground.
 - k. Sustained overload exceeding 100 percent of controller rated current.
 - l. Starting a rotating motor.
 - m. **<Insert features>**.
12. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
13. Automatic Reset and Restart:
- a. Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
 - b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.
14. Visual Indication: On face of controller; indicating the following conditions:
- a. Power on.
 - b. Run.
 - c. Overcurrent and overvoltage.
 - d. Motor speed (percent).
 - e. Various faults with alarm status.
 - f. Input kilovolt amperes.
 - g. Power factor.
 - h. Input kilowatts and kilowatt-hours.
 - i. Three-phase input and output voltage.
 - j. Three-phase input and output current.
 - k. Output frequency.
 - l. Elapsed operating time (hours).

- m. Diagnostic and service parameters.
 - n. **<Insert conditions>**.
- 15. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
 - 16. Control Signal Interface: A minimum of **[two]** **<Insert value>** analog inputs (0 to 10 V or 0/4 to 20 mA) and **[four]** **<Insert value>** programmable digital inputs.
 - 17. Bypass Controller:
 - a. Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
 - b. Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.
 - c. Include "Bypass/VFC" manual selector switch on face of enclosure for local operator control of preferred controller.
 - d. Include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.
 - e. Install bypass controller in same enclosure as variable-frequency controller.

2.16 CONTROLS

A. Vibration Switch: For each fan drive.

- 1. Enclosure: NEMA 250, **[Type 4]** **[Type 4X]** **<Insert Type>**.
- 2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
- 3. Switch shall have manual-reset button hardwired connection to fan motor electrical circuit.
- 4. Switch shall have field connection to a control system hardwired connection to fan motor electrical circuit.
- 5. Switch shall, on sensing excessive vibration, **[signal an alarm for connection to control system and]** shut down the fan.

B. Vibration Transmitter with Switch: For each fan drive.

- 1. Enclosure: NEMA 250, Type 4X.
- 2. Display: Local display of measured value, power, and alarm.
- 3. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point.
 - a. Cooling tower manufacturer shall select range that is suitable for cooling tower and recommend switch set point for proper operation and protection.
- 4. Transmitter: Continuous vibration level indication through a 4- to 20-mA signal for connection to control system.
- 5. Switch:
 - a. Relay and switch with manual-reset button for field connection to control system and hardwired connection to fan motor electrical circuit.
 - b. Switch shall, on sensing excessive vibration, signal an alarm to control system and shut down the fan.
- 6. Mounting: Locate out of cooling tower discharge airstream and mount in a location that is accessible **[and where display is easily viewable]**.
- 7. Field Electrical Connection Requirements: 120 V, single phase, 60 Hz.

- C. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch[**for connection to control system**].
 - 1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm[**through control system**].
- D. Control Package:
 - 1. Factory installed and wired, and functionally tested at factory before shipment.
 - 2. NEMA 250, [**Type 3R**] [**Type 4**] [**Type 4X**] enclosure with removable internally mount backplate.
 - 3. Control-circuit transformer with primary and secondary side fuses.
 - 4. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
 - 5. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
 - 6. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
 - 7. Collection basin level controller complying with requirements in [**"Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve"**] [**"Ultrasonic Collection Basin Water-Level Controller with Makeup-Water Valve"**] Paragraph in "Collection Basin Makeup-Water Assembly" Article.
 - 8. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Collection Basin Heater" Article.
 - 9. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
 - 10. Oil-level switch for each fan with a gear drive, complying with requirements in "Gear-Drive, Oil-Level Switch" Paragraph.
 - 11. Single-point, field-power connection to a [**fused disconnect switch**] [**nonfused disconnect switch**] [**circuit breaker**] [**for each cooling tower cell**].
 - a. Branch power circuit to each motor and electric basin heater and to controls[**with a disconnect switch or circuit breaker**].
 - b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Include variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
 - 12. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
 - 13. Visual indication of status and alarm[**with momentary test push button**] for each motor.
 - 14. Audible alarm and silence switch.
 - 15. Visual indication of elapsed run time, graduated in hours for each motor.
 - 16. Cooling tower shall have hardware to enable control system to remotely monitor and display the following:
 - a. Operational status of each motor.
 - b. Cooling tower leaving-fluid temperature.
 - c. Fan vibration alarm.
 - d. Oil-level alarm.
 - e. Collection basin [**high**] [**low**] [**high- and low**]-water-level alarms.
 - f. **<Insert conditions to be monitored>**.

2.17 SERVICE ACCESS

A. Doors:

Large enough for personnel to access cooling tower internal components from both cooling tower end walls.

1. A minimum of two doors shall be provided for access to each side of tower.
2. Doors shall be hinged with handles operable from both sides of the door.
3. Door materials shall match casing.
4. Hinges and handles shall be **[corrosion resistant] [stainless steel] <Insert material>**.

B. External Ladders with Safety Cages: **[Aluminum] [FRP] [galvanized-steel] [or] [stainless-steel] <Insert material>** fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

C. External Platforms with Handrails: **[Aluminum] [FRP] [galvanized-steel] [or] [stainless-steel] <Insert material>** bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

D. External Motor Platforms with Handrails: **[Aluminum] [FRP] [galvanized-steel] [or] [stainless-steel] <Insert material>** bar grating.

E. Fan Deck Floor between Cooling Tower Cells:

1. Factory furnish reinforced fan deck floor panels between cooling tower cells for field installation.
2. Floor materials shall match adjacent cooling tower cell fan deck.
3. Fan deck floor shall fasten to and be supported by framing that is attached to cooling tower cells.
4. Frame shall be constructed of same materials as cooling tower frame.

F. Handrail: **[Aluminum] [FRP] [galvanized steel] [or] [stainless steel] <Insert material>** complete with kneerail and toeboard, around external platforms and top of cooling tower. Comply with 29 CFR 1910.23.

G. Internal Platforms: **[Aluminum] [FRP] [galvanized-steel] [or] [stainless-steel] <Insert material>** bar grating.

1. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
2. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.
3. **<Insert platform locations>**.

H. Hardware: Galvanized steel when connecting galvanized-steel components; stainless steel when connecting other materials.

2.18 HOISTING ASSEMBLY

A. Hoisting assembly consisting of pedestal base, davit arm, and winch to accommodate lowering and raising cooling tower components from their installed location to the base of cooling tower supports.

1. Cooling tower components serviceable by hoisting assembly shall include, but not be limited to, fan stack, fan, fan drive, and fan motor.
2. Hoisting assembly shall be designed to accommodate heaviest single component plus a safety factor of **[1.5] <Insert value>**.

3. Construct cooling tower structural supports and reinforcing to accommodate lifting heaviest load with safety factor.

B. Pedestal Base:

1. Equip each cooling tower cell with a pedestal base to accommodate an easily removable davit arm and winch assembly.
2. Position pedestal base at a location on cooling tower fan (top) deck for hoisting assembly coverage to fan, fan motor, and fan drive assembly.
3. Pedestal base design shall be open-socket, or comparable, design that is configured to accept and secure an inserted portable davit arm.
4. Fit each pedestal base with an easily removable cap or plug designed to seal the open top of the base when the davit arm is not installed.
5. Fasten pedestal base to cooling tower using threaded hardware.
6. Construct pedestal base of **[hot-dip galvanized steel] [or] [300L series stainless steel]**.

C. Davit Arm:

1. Each cooling tower **[cell]** shall have a davit arm.
2. Davit arm shall be an adjustable telescoping design with angular adjustment to accommodate varying lifting conditions required by the application.
3. Davit arm assembly shall be portable and capable of being relocated to any cooling tower cell pedestal base.
4. Construct davit arm of **[hot-dip galvanized steel] [or] [300L series stainless steel]**.

D. Winch:

1. Each davit arm shall have **[an electric-] [or] [a hand-]**operated winch.
 - a. Electric winch shall include a power cord and plug for connection to a field-installed, weatherproof, 20-A receptacle with 120-V, single-phase, 60-Hz field power supply.
 - b. Hand-operated winch with gear mechanism to limit force on handle to not more than 80 lb (36 kg) when lifting the heaviest component.
2. Coat winch body and exposed components with corrosion-resistant finish that is rated for outdoor duty in a highly corrosive environment and exposed to direct sunlight.
3. Winch cable shall be stainless steel and terminated with a stainless-steel hook and quick disconnecting mechanism. Cable length shall be at least 1.5 times actual length required for application.

E. Hardware: **[304] [or] [316]** series stainless steel.

F. Nameplate:

1. Stamped or engraved aluminum or stainless-steel nameplate with rated load capacity on each davit arm and pedestal.
2. Letter size legible from a distance of 60 inches (1500 mm) and not less than 1/2 inch (13 mm).
3. Fasten nameplate at multiple points with stainless-steel rivets or screws.

2.19 SOURCE QUALITY CONTROL

- A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS, "Standard for the Certification of Water-Cooling Tower Thermal Performance."
1. Allow **[Owner]** **<Insert entity>** access to place where cooling towers are being tested. Notify Owner in writing at least **[30]** **<Insert number>** days in advance of testing.
 2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

- B. Seismic Performance Testing: Shake table tested by an independent [**or a factory-certified**] laboratory to certify performance complies with seismic requirements indicated.
 - 1. Allow [**Owner**] **<Insert entity>** access to place where cooling towers are being tested. Notify Owner in writing at least [**30**] **<Insert number>** days in advance of testing.
 - 2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- C. Factory Functional Tests:
 - 1. Test collection and distribution basins after assembly, and prove free of leaks.
 - 2. Test factory-installed electric/electronic water-level controls for proper operation.
 - 3. Test factory-installed electric basin heaters for proper operation.
 - 4. Test factory-installed fan and drive assemblies for proper operation.
 - 5. Test factory-installed control package for proper operation.
 - 6. Test access doors to ensure smooth operation and proper fit.
 - 7. **<Insert additional functional test requirements>**.
 - 8. Allow [**Owner**] **<Insert entity>** access to place where cooling towers are being tested. Notify Owner in writing at least [**30**] **<Insert number>** days in advance of testing.
 - 9. Submit report documenting tests performed and results within one week of test date.
- D. Owner Travel Expenses:
 - 1. Include cost associated with Owner travel expenses to witness testing. Total value attributed to travel expenses shall be clearly indicated.
 - 2. Expenses shall include round-trip coach airfare, out of town hotel accommodations, out of town meals (breakfast, lunch, and dinner), out of town ground transportation, and all associated taxes and fees.
 - 3. Exclude other incidental expenses not indicated.
 - 4. Include travel expenses for [**one**] [**two**] **<Insert value>** Owner representative(s) with origin of **<Insert city, state, and country>**.

PART 3 - EXECUTION – NOT USED

END OF SECTION 236514.14

SECTION 236514.16 - CLOSED CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Baltimore Aircoil Company.
 - 2. EVAPCO, Inc.
 - 3. Recold.
 - 4. **<Insert manufacturer's name>.**

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cooling tower support structure[**and seismic restraints**] [**and wind restraints**], including comprehensive engineering analysis.
- B. Structural Performance: Cooling tower and support structure shall withstand the effects of loads and stresses within limits and under conditions indicated according to [ASCE/SEI 7] [the IBC] [governing code] **<Insert requirement>.**
- C. Seismic Performance: Cooling towers 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. Component Importance Factor: [1.5] [1.0].
 - 3. Component Amplification Factor: **<Insert value>.**
 - 4. Component Response Modification Factor: **<Insert value>.**
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
- 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.
- F. Operation Following Loss of Normal Power:
 - 1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
 - 2. Include means and methods required to satisfy requirement even if not explicitly indicated.

G. Vibration:

1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry standard requirements for cooling towers.
2. Critical speed shall be at least 115 percent of design speed.

2.4 DESIGN ARRANGEMENT

- A. Counterflow design with airflow from all sides and induced-draft, top-mounted axial fan and pressurized pipe distribution.

2.5 CASING AND FRAME

- A. Casing Material: **[Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating] [Polymer-coated galvanized steel] [Stainless steel, Grade 304] [Stainless steel, Grade 316] <Insert material>**.
- B. Frame Material: **[Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating] [polymer-coated galvanized steel] [stainless steel, Grade 304] [stainless steel, Grade 316] [or] [materials to match casing] <Insert material>**.
- C. Hardware: **[Galvanized] [or] [stainless]** steel.
- D. Joints and Seams: Sealed watertight.
- E. Welded Connections: Sealed watertight **[by continuous welds]**.

2.6 COLLECTION BASIN

- A. Factory-Assembled Collection Basin:
1. Material: **[Galvanized steel, ASTM A 653/A 653M, G235 (Z700) coating] [Polymer-coated galvanized steel] [Stainless steel, Grade 304] [Stainless steel, Grade 316] <Insert material>**.
 2. Hardware: **[Galvanized] [or] [stainless]** steel.
 3. Joints and Seams: Sealed watertight.
 4. Welded Connections: Sealed watertight **[by continuous welds]**.
 5. Removable **[stainless-steel]** strainer with openings smaller than nozzle orifices.
 6. Overflow and drain connections.
 7. Makeup-water connection.
 8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
 9. Basin Sweeper Distribution Piping and Nozzles:
 - a. Pipe Material: **[PVC] <Insert material>**, Schedule 40 or heavier, treated with UV inhibitors and intended for continuous exposure to direct sunlight with degradation.
 - b. Nozzle Material: **[Plastic] <Insert material>**.
 - c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.
 - d. Basin penetrations sealed watertight.
 - e. Field Connections: Threaded or flanged depending on pipe size. Threaded for sizes through **<Insert pipe size>** and flanged for larger sizes.

2.7 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

- A. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
- B. Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve:
1. Enclosures: NEMA 250, **[Type 4] [Type 4X] <Insert Type>**.

2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to **[control makeup-water valve] [control makeup-water valve and low-level alarm] [control makeup-water valve and low- and high-level alarms] [control makeup-water valve, low- and high-level alarms, and output for shutoff of pump on low level]**.
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: **[Corrosion-resistant material] [FRP] [Galvanized steel] [PVC pipe] [Stainless steel, Grade 304] [Stainless steel, Grade 316] <Insert material>**.
5. Makeup-Water Valve:
 - a. Slow closing **[with stainless-steel body]**.
 - b. Valve actuator controlled and powered through level controller in response to water-level set point.
 - c. Actuator Enclosure: NEMA 250, **[Type 4] [Type 4X] <Insert Type>**.
 - d. Fail Position: **[Closed] [Open] [Last]**.
 - e. Action: **[Two position] [or] [modulating]**.
6. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

2.8 COLLECTION BASIN HEATER

A. Electric Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, **[Type 3R] [Type 4] [Type 4X] <Insert Type>**.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a **[fused disconnect switch] [nonfused disconnect switch] [circuit breaker]** and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.
 - a. Raceway shall be corrosion-resistant **[stainless steel] [or] [PVC coated steel]**.

2.9 PRESSURIZED DISTRIBUTION NETWORK

- A. Main header and lateral branch piping designed for even distribution over heat-exchanger coils throughout the entire flow range without the need for balancing valves and for connecting individual, easily removable, nonclogging spray nozzles.
- B. Pipe Material: **[Schedule 40 PVC] <Insert material>**.
- C. Spray Nozzle Material: **[Plastic] [Polypropylene] [or] [PVC] <Insert material>**.
- D. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

2.10 HEAT-EXCHANGER COILS

- A. Tube and Tube Sheet Materials: **[Copper tube with stainless-steel tube sheet] [stainless-steel tube and tube sheet] [or] [carbon-steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication]**.

B. Heat-Exchanger Arrangement:

1. **[Serpentine tubes] [Serpentine tubes with removable cover plate on inlet and outlet headers] [or] [straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube]**; sloped for complete drainage of fluid by gravity.
2. Tubes with extended surface fins if required to achieve performance indicated.
3. Multiple Separate Circuits: Separate circuits to achieve multiple isolated loops as required by application.

C. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; sloped for complete drainage of fluid by gravity.

D. Field Piping Connections: Vent, supply, and return[**suitable for mating to ASME B16.5, Class 150 flange**].

2.11 DRIFT ELIMINATORS

- A. Material: **[PVC] <Insert material>**; with maximum flame-spread index of **[5] [25] <Insert number>** according to ASTM E 84.
- B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
- C. Arrangement: Multiple, easily removable sections.
- D. Configuration: Multipass, designed and tested to reduce water carryover to **[0.001] <Insert number>** percent of design flow rate indicated.
- E. Hardware: **[Galvanized] [or] [stainless]** steel.

2.12 AIR INLET

- A. Air-Intake Louvers:
1. Material: **[PVC] <Insert material>**.
 2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
 3. Multiple, easily removable sections arranged to uniformly direct air into cooling tower, to minimize air resistance, to block direct sunlight, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
- B. Hardware: **[Galvanized] [or] [stainless]** steel.

2.13 FAN AND DRIVE ASSEMBLY

- A. Axial Fan: Balanced at the factory[**after assembly**].
1. Blade Material: **[Aluminum] [FRP] [or] [galvanized steel] <Insert material>**.
 2. Blade Pitch: Field adjustable.
 3. Fan Shaft: **[Corrosion resistant] [Stainless steel] <Insert material>**.
 4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F (minus 29 and plus 149 deg C). Bearings designed for an L-10 life of **[40,000] [50,000] [100,000] <Insert value>** hours.
 5. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
 6. Fan Assembly shall provide vibration monitoring.
 7. Automatic Bearing Greasing System:

- a. Manufacturer designed system to provide an as needed supply of new grease to bearings while reducing the need for periodic bearing maintenance and associated greasing problems.
 - b. Easily replaceable storage container filled with recommended grease and located in an easily accessible location on cooling tower exterior. Container capacity of sufficient size to provide grease for **[one year]** **<Insert time period>**.
8. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.
 - a. Fan Assembly shall provide vibration monitoring.
- B. Fan Motor:
 1. Comply with NEMA MG 1 unless otherwise indicated.
 2. Description: NEMA MG 1, **[Design B]** **<Insert design>**, as required to comply with capacity and torque characteristics; medium induction motor.
 3. 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.
 4. Motor Enclosure: **[Open dripproof with weather protective cover]** **[totally enclosed]** **[totally enclosed air-over (TEAO)]** **[or]** **[totally enclosed fan-cooled (TEFC)]** **[with epoxy or polyurethane finish]**.
 5. Rotor: Random-wound, squirrel cage.
 6. Energy Efficiency: **[Comply with ASHRAE/IES 90.1]** **[NEMA Premium Efficient]**.
 7. Service Factor: **[1.15]** **<Insert value>**.
 8. Temperature Rise: **[Match]** **[One class lower than]** **<Insert requirements>** insulation rating.
 9. Insulation: **[Class F]** **[Class H]** **<Insert class>**.
 10. Variable-Speed Motors: Inverter-duty rated per NEMA MG 1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
 11. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
 12. Motor Base: Adjustable, or other suitable provision **[for adjusting belt tension]**.
 13. Motor Shaft Grounding: Motors shall be controlled through variable-frequency controllers with shaft grounding system to protect motor bearings from induced voltage. Drag on motor shaft due to shaft ground system shall be less than **[0.5]** **<Insert value>** percent of motor nameplate horsepower.
- C. Hardware: **[Galvanized]** **[or]** **[stainless]** steel.

2.14 AIR DISCHARGE

- A. Fan Discharge Stack:
 1. Manufacturer's standard low-profile design.
 2. Material: **[Material to match casing]** **<Insert material>**.
 3. Stack Extension: Fabricated to extend above fan deck **<Insert distance>** unless otherwise indicated.
 4. Stack Termination: Wire-mesh, **[galvanized-steel]** **[polymer-coated, galvanized-steel]** **[or]** **[stainless-steel]** **<Insert material>** screens; segmented into multiple removable pie sections and complying with OSHA regulations.
- B. Discharge Hood:

1. Hood Configuration: **[Tapered] [Straight]**; totally surrounding heat exchanger, pressurized distribution system and drift eliminators; constructed of same material as casing; and having factory-installed **[insulation and]**access doors.
 2. Discharge Dampers: Positive-closure, automatic, isolation dampers constructed of **[aluminum] [galvanized steel] [stainless steel] <Insert material>** with corrosion-resistant linkages and electric actuators with NEMA 250, Type 4X enclosure.
 - a. If not provided with factory controls, field-connect provisions for electrical power and controls to open dampers when pump is energized and close dampers when pump is de-energized.
 3. Capacity-Control Dampers: **[Aluminum] [Galvanized-steel] [Stainless-steel] <Insert material>** dampers, with corrosion-resistant linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.
 - a. If not provided with factory controls, provide field power and controls to operate dampers when pump is energized and close dampers when pump and fan is de-energized.
- C. Hardware: **[Galvanized] [or] [stainless]** steel.
- 2.15 RECIRCULATING WATER DISTRIBUTION SYSTEM
- A. Pump: Close-coupled, single-stage, **[bronze-fitted]**centrifugal pump; with mechanical seal and suitable for outdoor service. Factory install pump with following:
1. Redundant Pump: Same performance as required for primary pump; easily switched and maintained while cooling tower remains operating.
 2. Flanges at pump connections to piping.
 3. Strainer[, **with blowdown isolation valve,**] installed in piping on suction side of pump.
 4. Flow balancing valve in piping on discharge side of pump.
- B. Pump Motor:
1. Comply with NEMA MG 1 unless otherwise indicated.
 2. Description: NEMA MG 1, **[Design B] <Insert design>**, as required to comply with capacity and torque characteristics; medium induction motor.
 3. 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.
 4. Motor Enclosure: **[Open dripproof] [or] [totally enclosed] [and with epoxy or polyurethane finish]**.
 5. Rotor: Random-wound, squirrel cage.
 6. Energy Efficiency: **[Comply with ASHRAE/IES 90.1] [NEMA Premium Efficient]**.
 7. Service Factor: **[1.15] <Insert value>**.
 8. Temperature Rise: **[Match] [One class lower than] <Insert requirements>** insulation rating.
 9. Insulation: **[Class F] [Class H] <Insert class>**.
- C. Piping: Interconnecting collection basin to pump and pressurization distribution system.
1. Design delegated to manufacturer.
 2. External to and supported from cooling tower casing and frame.
 3. Material: **[Corrosion resistant] [PVC] <Insert material>**.
 4. Install flanges at connections to collection basin and pressurized distribution system.
 5. Drain connection with isolation valve at piping low point if piping does not drain directly into collection basin.

- D. Piping: Field installed for connection to remotely installed pump and water storage that are not furnished with cooling tower.

2.16 ELECTRICAL POWER

- A. Factory Furnish for Field Installation: A **[disconnect switch] [motor controller] [variable-frequency controller]** for each fan motor and a **[disconnect switch] [motor controller]** for each pump motor.
- B. Factory Install: A **[disconnect switch] [motor controller] [variable-frequency controller]** for each fan motor and a **[disconnect switch] [motor controller]** for each pump motor.
 - 1. Locate in a convenient and field-accessible location within sight of motor.
 - 2. Installation shall comply with NFPA 70.
 - 3. Wire, Conduit, and Enclosures:

Minimum Conduit Size: **[0.75 inch (20 mm)] <Insert size>**.

- a. Materials: Corrosion resistant **[and constructed of stainless steel or PVC coated steel]**.
- b. Motor Termination: Liquidtight conduit, not to exceed 36 inches (900 mm) long.
- c. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware **[constructed of stainless steel]**.
- d. Wire:

Copper, rated for 600-V, solid wire for size **[No. 10 AWG] <Insert wire size>** and smaller and stranded wire for larger sizes.

- 1) Minimum Wire Size: **[No. 12 AWG] <Insert wire size>**.
- 2) Each circuit shall have a ground wire.
- 3) Install wire in conduit.

- e. Boxes, Condulets, and Enclosures: NEMA 250, **[Type 3R] [Type 4] [Type 4X]**.

C. Disconnect Switches:

- 1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
- 2. Three pole, **[fused] [or] [nonfused]**.
- 3. 600 V rated.
- 4. Minimum SCCR: As required by electrical power distribution system, but not less than **[42,000] [65,000] <Insert value> A**.
- 5. Enclosure: NEMA 250, **[Type 3R] [Type 4] [Type 4X] [or] [Type 4X stainless steel] <Insert Type>**.
- 6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
- 7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
- 8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
- 9. Include a solid neutral as required by authorities having jurisdiction.
- 10. Provide a ground lug for ground wire termination.
- 11. Operating handle shall be lockable in open position.
- 12. Horsepower rated.
- 13. Feed through or double lugged.

D. Motor Controllers:

- 1. NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller.
- 2. Configured for control of single- or multispeed motors as indicated.

3. Enclosure: NEMA 250, [Type 3R] [Type 4] [Type 4X] [or] [Type 4X stainless steel] <Insert Type>, with hinged full-front access door with lock and key.
 4. Externally Operated[, Door-Interlocked] Disconnect: [Fused disconnect switch] [Nonfused disconnect switch] [Circuit breaker] with lockable handle.
 5. SCCR shall be as required by electrical power distribution system, but not less than [42,000] [65,000] <Insert value> A.
 6. Hand-Off-Auto Switch: Mounted on face of enclosure.
 7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.
 8. Control Relays: Time-delay relays.
 9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
 10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
 11. Number-of-Starts Counter: Numerical readout on face of enclosure.
- E. Variable-Frequency Controllers:
1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.
 2. Enclosure: Unit mounted, NEMA 250, [Type 3R] [Type 4] [Type 4X] [or] [Type 4X stainless steel] <Insert Type>, with hinged full-front access door with lock and key.
 3. Externally Operated[, Door-Interlocked] Disconnect: [Fused disconnect switch] [Nonfused disconnect switch] [Circuit breaker] with lockable handle.
 4. Minimum SCCR shall be as required by electrical power distribution system, but not less than [42,000] [65,000] <Insert value> A.
 5. Technology: Pulse-width-modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
 6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
 7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
 8. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.
 9. Operating Requirements:
 - a. Input AC Voltage Tolerance: [10] <Insert number> percent.
 - b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
 - c. Capable of driving full motor load, without derating.
 - d. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - e. Minimum Displacement Primary-Side Power Factor: 95 percent.
 - f. Overload Capability: 1.05 times the full-load current for 7 seconds.
 - g. Starting Torque: As required by fan and motor drive assembly.
 - h. Speed Regulation: 1 percent.
 - i. Speed Range: 10:1 speed range.
 - j. To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
 - k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.
 10. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
 11. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:
 - a. Overtemperature.
 - b. Short circuit at controller output.

- c. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
 - d. Open circuit at controller output.
 - e. Input undervoltage.
 - f. Input overvoltage.
 - g. Loss of input phase.
 - h. Reverse phase.
 - i. AC line switching transients.
 - j. Instantaneous overload, line to line or line to ground.
 - k. Sustained overload exceeding 100 percent of controller rated current.
 - l. Starting a rotating motor.
 - m. **<Insert features>**.
12. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
13. Automatic Reset and Restart:
- a. Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
 - b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.
14. Visual Indication: On face of controller; indicating the following conditions:
- a. Power on.
 - b. Run.
 - c. Overcurrent and overvoltage.
 - d. Motor speed (percent).
 - e. Various faults with alarm status.
 - f. Input kilovolt amperes.
 - g. Power factor.
 - h. Input kilowatts and kilowatt-hours.
 - i. Three-phase input and output voltage.
 - j. Three-phase input and output current.
 - k. Output frequency.
 - l. Elapsed operating time (hours).
 - m. Diagnostic and service parameters.
 - n. **<Insert conditions>**.
15. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
16. Control Signal Interface: A minimum of [**two**] **<Insert value>** analog inputs (0 to 10 V or 0/4 to 20 mA) and [**four**] **<Insert value>** programmable digital inputs.
17. Bypass Controller:
- a. Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
 - b. Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.
 - c. Include "Bypass/VFC" manual selector switch on face of enclosure for local operator control of preferred controller.
 - d. Include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.
 - e. Install bypass controller in same enclosure as variable-frequency controller.

2.17 CONTROLS

A. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, **[Type 4] [Type 4X] <Insert Type>**.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Switch shall have manual-reset button hardwired connection to fan motor electrical circuit.
4. Switch shall have field connection to a control system hardwired connection to fan motor electrical circuit.
5. Switch shall, on sensing excessive vibration, **[signal an alarm for connection to control system and]** shut down the fan.

B. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. Factory installed and wired, and functionally tested at factory before shipment.
2. NEMA 250, **[Type 3R] [Type 4] [Type 4X]** enclosure with removable internally mount backplate.
3. Control-circuit transformer with primary and secondary side fuses.
4. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
5. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
6. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
7. Collection basin level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve" Paragraph in "Collection Basin Makeup-Water Assembly" Article.
8. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Collection Basin Heater" Article.
9. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
10. Single-point, field-power connection to a **[fused disconnect switch] [nonfused disconnect switch] [circuit breaker] [for each cooling tower cell]**.
 - a. Branch power circuit to each motor and electric basin heater and to controls **[with a disconnect switch or circuit breaker]**.
 - b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
11. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
12. Visual indication of status and alarm **[with momentary test push button]** for each motor.
13. Audible alarm and silence switch.
14. Visual indication of elapsed run time, graduated in hours for each motor.
15. Cooling tower shall have hardware to enable control system to remotely monitor and display the following:
 - a. Operational status of each motor.
 - b. Cooling tower leaving-fluid temperature.
 - c. Fan vibration alarm.
 - d. Collection basin **[high] [low] [high- and low]-water-level** alarms.

e. **<Insert conditions to be monitored>.**

2.18 WATER TREATMENT

- A. Chemical-Free Water Treatment System: Complete factory-installed system consisting of the following:
1. Pulsed-power technology emitting high-frequency bursts of low energy electromagnetic fields to the recirculated water to control corrosion, bacteria, and scale.
 2. Conductivity control of electrically operated valve designed to control totally dissolved solids levels and bleed rates.
 3. Piping associated with system.
 4. Interconnecting power and control wiring installed in corrosion-resistant metal raceway.
- B. Chemical Water Treatment System: Complete factory-installed system consisting of the following:
1. Microprocessor-controlled conductivity controller housed in NEMA 250, Type 4X enclosure.
 2. Chemical metering pump housed in NEMA 250, Type 4X enclosure.
 3. Electrically operated valve designed to control totally dissolved solids levels and bleed rates.
 4. Piping associated with system.
 5. Interconnecting power and control wiring installed in corrosion-resistant metal raceway.

2.19 SERVICE ACCESS

A. Doors:

Large enough for personnel to access cooling tower internal components.

1. A minimum of two doors shall be provided for access to either side of Tower.
 2. Doors shall be hinged with handles operable from both sides of the door.
 3. Door materials shall match casing.
 4. Hinges and handles shall be **[corrosion resistant] [stainless steel] <Insert material>.**
- B. External Ladders with Safety Cages: **[Aluminum] [galvanized-steel] [or] [stainless-steel] <Insert material>** fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
- C. External Platforms with Handrails: **[Aluminum] [galvanized-steel] [or] [stainless-steel] <Insert material>** bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
- D. External Motor Platforms with Handrails: **[Aluminum] [galvanized-steel] [or] [stainless-steel] <Insert material>** bar grating.
- E. Fan Deck Floor between Cooling Tower Cells:
1. Factory furnish reinforced fan deck floor panels between cooling tower cells for field installation.
 2. Floor materials shall match adjacent cooling tower cell fan deck.
 3. Fan deck floor shall fasten to and be supported by framing that is attached to cooling tower cells.
 4. Frame shall be constructed of same materials as cooling tower frame.
- F. Handrail: **[Aluminum] [galvanized steel] [or] [stainless steel] <Insert material>** complete with kneerail and toeboard, around external platforms and top of cooling tower. Comply with 29 CFR 1910.23.

- G. Internal Platforms: **[Aluminum] [galvanized-steel] [or] [stainless-steel] <Insert material>** bar grating.
1. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between. Platform shall be elevated so that all parts are above the high water level of the collection basin.
 2. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach.
 3. **<Insert platform locations>**.
- H. Hardware: Galvanized steel when connecting galvanized-steel components; stainless steel when connecting other materials.

2.20 HOISTING ASSEMBLY

- A. Hoisting assembly consisting of pedestal base, davit arm, and winch to accommodate lowering and raising cooling tower components from their installed location to the base of cooling tower supports.
1. Cooling tower components serviceable by hoisting assembly shall include, but not be limited to, fan stack, fan, fan drive, and fan motor.
 2. Hoisting assembly shall be designed to accommodate heaviest single component plus a safety factor of **[1.5] <Insert value>**.
 3. Construct cooling tower structural supports and reinforcing to accommodate lifting heaviest load with safety factor.
- B. Pedestal Base:
1. Equip each cooling tower cell with a pedestal base to accommodate an easily removable davit arm and winch assembly.
 2. Position pedestal base at a location on cooling tower for hoisting assembly coverage to fan, fan motor, and fan drive assembly.
 3. Pedestal base design shall be open-socket, or comparable, design that is configured to accept and secure an inserted portable davit arm.
 4. Fit each pedestal base with an easily removable cap or plug designed to seal the open top of the base when the davit arm is not installed.
 5. Fasten pedestal base to cooling tower using threaded hardware.
 6. Construct pedestal base of **[hot-dip galvanized steel] [or] [300L series stainless steel]**.
- C. Davit Arm:
1. Each cooling tower **[cell]** shall have a davit arm.
 2. Davit arm shall be an adjustable telescoping design with angular adjustment to accommodate varying lifting conditions required by the application.
 3. Davit arm assembly shall be portable and capable of being relocated to any cooling tower cell pedestal base.
 4. Construct davit arm of **[hot-dip galvanized steel] [or] [300L series stainless steel]**.
- D. Winch:
1. Each davit arm shall have **[an electric-] [or] [a hand-]**operated winch.
 - a. Electric winch shall include a power cord and plug for connection to a field-installed, weatherproof, 20-A receptacle with 120-V, single-phase, 60-Hz field power supply.
 - b. Hand-operated winch with gear mechanism to limit force on handle to not more than 80 lb (36 kg) when lifting the heaviest component.

2. Coat winch body and exposed components with corrosion-resistant finish that is rated for outdoor duty in a highly corrosive environment and exposed to direct sunlight.
 3. Winch cable shall be stainless steel and terminated with a stainless-steel hook and quick disconnecting mechanism. Cable length shall be at least 1.5 times actual length required for application.
- E. Hardware: **[304]** **[or]** **[316]** series stainless steel.
- F. Nameplate:
1. Stamped or engraved aluminum or stainless-steel nameplate with rated load capacity on each davit arm and pedestal.
 2. Letter size legible from a distance of 60 inches (1500 mm) and not less than 1/2 inch (13 mm).
 3. Fasten nameplate at multiple points with stainless-steel rivets or screws.

2.21 SOURCE QUALITY CONTROL

- A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS, "Standard for the Certification of Water-Cooling Tower Thermal Performance."
1. Allow **[Owner]** **<Insert entity>** access to place where cooling towers are being tested. Notify Owner in writing at least **[30]** **<Insert number>** days in advance of testing.
 2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- B. Seismic Performance Testing: Shake table tested by an independent**[or a factory-certified]** laboratory to certify performance complies with seismic requirements indicated.
1. Allow **[Owner]** **<Insert entity>** access to place where cooling towers are being tested. Notify Owner in writing at least **[30]** **<Insert number>** days in advance of testing.
 2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- C. Factory Functional Tests:
1. Test collection and distribution basins after assembly, and prove free of leaks.
 2. Test factory-installed electric/electronic water-level controls for proper operation.
 3. Test factory-installed electric basin heaters for proper operation.
 4. Test factory-installed fan and drive assemblies for proper operation.
 5. Test factory-installed control package for proper operation.
 6. Test access doors to ensure smooth operation and proper fit.
 7. **<Insert additional functional test requirements>**.
 8. Allow **[Owner]** **<Insert entity>** access to place where cooling towers are being tested. Notify Owner in writing at least **[30]** **<Insert number>** days in advance of testing.
 9. Submit report documenting tests performed and results within one week of test date.
- D. Heat-Exchanger Factory Pressure and Leak Tests:
1. Pneumatically test heat-exchanger assembly while submerged underwater and prove to be free of leaks.
 2. Test pressure equal to **[1.5]** **<Insert value>** times rated pressured, but not less than **<Insert psig (kPa)>**.
 3. Submit report documenting test and results.
- E. Owner Travel Expenses:
1. Include cost associated with Owner travel expenses to witness testing. Total value attributed to travel expenses shall be clearly indicated.

2. Expenses shall include round-trip coach airfare, out of town hotel accommodations, out of town meals (breakfast, lunch, and dinner), out of town ground transportation, and all associated taxes and fees.
3. Exclude other incidental expenses not indicated.
4. Include travel expenses for [one] [two] <Insert value> Owner representative(s) with origin of <Insert city, state, and country>.

PART 3 - EXECUTION – NOT USED

END OF SECTION 236514.16

SECTION 237313.16 - INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

1.1 SUMMARY – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following:
 - 1. Material reuse.
 - 2. Recycled content.
 - 3. Adhesives: VOC content and emissions evaluation.
 - 4. Sealants: VOC content and emissions evaluation.
- 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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- G. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."
- H. Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative 8-inch wg (2000 Pa) of internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch (0.0042 mm/mm) of panel span.
- I. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8 inch wg (2000 Pa).

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

ENVIRO-TEC; by Johnson Controls, Inc.

- 1. Buffalo Air Handling.
- 2. Carrier Corporation; a unit of United Technologies Corp.
- 3. Coil Company, LLC.
- 4. Daikin Applied.
- 5. Dunham-Bush, Inc.
- 6. Trane.
- 7. USA Coil & Air.
- 8. YORK; a Johnson Controls company.

2.3 UNIT CASINGS

- A. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.
- B. Base Rail:
 - 1. Material: **[Galvanized steel] [Welded structural steel] <Insert material>**.
 - 2. Height: **[6 inches (150 mm)] <Insert dimension>**.
- C. Casing Joints: Hermetically sealed at each corner and around entire perimeter.
- D. Double-Wall Construction:
 - 1. Outside Casing Wall:
 - a. Material, Galvanized Steel: Minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] [14 gauge (2.0 mm)] <Insert value> thick**.
 - b. Material, Aluminum: Minimum **[16 gauge (1.3 mm)] [14 gauge (1.6 mm)] [12 gauge (2.0 mm)] <Insert value> thick**.
 - c. Material, Stainless Steel: Minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] [14 gauge (2.0 mm)] <Insert value> thick**.
 - d. Factory Finish: Provide **[manufacturer's standard finish] <Insert special coating>**.
 - 2. Inside Casing Wall:
 - a. Material, Galvanized Steel: **[Solid] [Perforated]**, minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] <Insert value> thick**.
 - b. Material, Aluminum: **[Solid] [Perforated]**, minimum **[16 gauge (1.3 mm)] [14 gauge (1.6 mm)] <Insert value> thick**.
 - c. Material, Stainless Steel: **[Solid] [Perforated]**, minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] <Insert value> thick**.
 - d. Antimicrobial Coating: Applied during the manufacturing process. **[EPA approved] [NSF approved] [FDA listed]**.
- E. Floor Plate:
 - 1. Material, Galvanized Steel: **[Treadplate,] minimum [18 gauge (1.3 mm)] [16 gauge (1.6 mm)] [14 gauge (2.0 mm)] [12 gauge (2.7 mm)] [10 gauge (3.5 mm)] <Insert value> thick**.
 - 2. Material, Aluminum: **[Treadplate,] minimum [18 gauge (1.0 mm)] [16 gauge (1.3 mm)] [14 gauge (1.6 mm)] [12 gauge (2.0 mm)] [10 gauge (2.6 mm)] <Insert value> thick**.
 - 3. Material, Stainless Steel: **[Treadplate,] minimum [18 gauge (1.3 mm)] [16 gauge (1.6 mm)] [14 gauge (2.0 mm)] [12 gauge (2.8 mm)] [10 gauge (3.5 mm)] <Insert value> thick**.
 - 4. Antimicrobial Coating: Applied during the manufacturing process. **[EPA approved] [NSF approved] [FDA listed]**.
- F. Casing Insulation:
 - 1. Materials: **[Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071] [Injected polyurethane foam insulation] [Glass-fiber insulation layered over injected foam in perforated interior casing sections to meet specified acoustic requirements]**.
 - 2. Casing Panel R-Value: Minimum **[R-11] [R-13] <Insert value>**.
 - 3. Insulation Thickness: **[2 inches (50 mm)] <Insert dimension>**.
 - 4. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

- G. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- H. Static-Pressure Classifications:
 - 1. For Unit Sections Upstream of Fans: Minus **[2-inch wg (500 Pa)] [3-inch wg (750 Pa)] [4-inch wg (1000 Pa)] [6-inch wg (1500 Pa)]** <Insert value>.
 - 2. For Unit Sections Downstream and Including Fans: **[2-inch wg (500 Pa)] [3-inch wg (750 Pa)] [4-inch wg (1000 Pa)] [6-inch wg (1500 Pa)]** <Insert value>.
- I. Panels, Doors, and Windows:
 - 1. Panels:
 - a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least **[18 inches (450 mm)] [24 inches (600 mm)]** <Insert dimension> wide by full height of unit casing up to a maximum height of **[60 inches (1500 mm)] [72 inches (1800 mm)]** <Insert dimension>.
 - 2. Doors:
 - a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least **[18 inches (450 mm)] [24 inches (600 mm)]** <Insert dimension> wide by full height of unit casing up to a maximum height of **[60 inches (1500 mm)] [72 inches (1800 mm)]** <Insert dimension>.
 - 3. Windows:
 - a. Construction: Fabricate windows in access panels and doors of double-glazed, safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
 - b. Size: Minimum 6 inches (150 mm), square or round.
 - 4. Locations and Applications:
 - a. Fan Section: **[Doors] [Panels]**, with windows.
 - b. Coil Section: **[Panels]**.
 - c. Access Section: **[Doors] [Panels]**, with windows.
 - d. Access Sections Immediately Upstream and Downstream of Coil Sections: **[Doors] [Panels]**, with windows.
 - e. Damper Section: **[Doors] [Panels]**, with viewing windows.
 - f. Filter Section: **[Doors] [Panels]** large enough to allow periodic removal and installation of filters.
 - g. Access Sections Immediately **[Upstream] [and] [Downstream]** of Filter Sections: **[Doors] [Panels]**, with windows.

- h. Mixing Section: **[Doors] [Panels]**, with windows.
 - i. Humidifier Section: **[Doors] [Panels]**, with windows.
- 5. Service Lights: LED vaporproof luminaire with individual switched junction box located **[outside] [inside]**, adjacent to each access door and panel.
 - a. Locations: **[Each section accessed with door or panel] [Fan section] <Insert location>**.
- 6. Convenience Outlets: One 20-A duplex GFCI receptacle per location with junction box located on outside casing wall.
 - a. Locations: **[Each section accessed with a door or panel] [Fan section] <Insert location>**.
- J. Condensate Drain Pans:
 - 1. Construction:
 - a. Single-wall, stainless-steel sheet.
 - b. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - 2. Drain Connection:
 - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on **[one end] [both ends]** of pan.
 - b. Minimum Connection Size: **[NPS 1 (DN 25)] [NPS 2 (DN 50)] <Insert pipe size>**.
 - 3. Slope: Minimum 0.125-in./ft. (10-mm/mm) slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - 4. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
 - 5. Width: Entire width of water producing device.
 - 6. Depth: A minimum of 2 inches (50 mm) deep.
 - 7. **[Formed sections] [Integral part of floor plating]**.
 - 8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
 - 9. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
 - 10. Provide splash guard on chilled water coil.

2.4 FAN, DRIVE, AND MOTOR SECTION

Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

- A. In most instances direct drive will be preferred over belt drive.
- B. Fans: Centrifugal, galvanized steel; mounted on solid-steel shaft.
 - 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 - 2. Shaft Bearings:
 - a. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L-50 rated life of 200,000 hours according to ABMA 9.

- b. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and two-piece, cast-iron housing[**with grease lines extended to outside unit**] and an L-50 rated life of 200,000 hours according to ABMA 11.
 - c. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing[**with grease lines extended to outside unit**] and an L-50 rated life of 200,000.
 - 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 4. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
 - 5. Plenum Fan Arrays: [**Contained**] [**Uncontained**] as defined in AHRI 430. Steel or aluminum frame with inlet cone and structural framing around each fan built into an array of multiple fans. Provide [**backdraft**] [**motorized**] dampers at each fan to prevent short circuiting of flow if one fan is not operating.
 - 6. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; [**steel**] [**aluminum**] hub riveted to backplate and fastened to shaft with setscrews.
 - 7. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; [**steel**] [**aluminum**] hub swaged to backplate and fastened to shaft with setscrews.
 - 8. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
 - 9. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**] [**2 inches (50 mm)**] **<Insert dimension>**.
 - 10. Shaft Lubrication Lines: Extended to a location outside the casing.
 - 11. Flexible Connector: Factory fabricated with a fabric strip minimum [**3-1/2 inches (89 mm)**] [**5-3/4 inches (146 mm)**] **<Insert dimension>** wide, attached to two strips of minimum [**2-3/4-inch- (70-mm)-wide**] **<Insert dimension>** by [**0.028-inch- (0.7-mm)- thick, galvanized-steel sheet**] [**0.032-inch- (0.8-mm)- thick, aluminum sheets**].
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
 - 1) Fabric Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 - 2) Fabric Minimum Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3) Fabric Minimum Service Temperature Range: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
- C. Drive, Direct: Factory-mounted, direct drive.
- D. Drive, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
 - 1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
 - 2. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.

3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch- (2.7-mm-) thick, 3/4-inch (20-mm) diamond-mesh wire screen, welded to steel angle frame; prime coated
- E. Motors:
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 3. Enclosure Type: [**Open, dripproof**] [**Totally enclosed, fan cooled**] <Insert type>.
 4. Enclosure Materials: Cast iron.
 5. Motor Bearings: <Insert requirements>.
 6. Unusual Service Conditions:
 - a. Ambient Temperature: <Insert deg C>.
 - b. Altitude: <Insert feet (m)> above sea level.
 - c. High humidity.
 - d. <Insert conditions>.
 7. Efficiency: Premium Efficient motors as defined in NEMA MG 1.
 8. NEMA Design: <Insert designation>.
 9. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
 10. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 11. <Insert unique motor characteristics>.
 12. Mount unit-mounted disconnect switches on [**exterior**] [**interior**] of unit.
- F. Comply with Section 262923 "Variable-Frequency Motor Controllers."
- G. Variable-Frequency Motor Controller: Serving [**each fan individually**] [**all fans combined**] in fan array.
1. Manufactured Units: Pulse-width modulated; [**constant torque**] [**and**] [**variable torque**] <Insert application> for [**Design A and Design B**] [**inverter-duty**] motors.
 2. Output Rating: Three phase; 10 to [**60 Hz, with voltage proportional to frequency throughout voltage range**] [**66 Hz, with torque constant as speed changes**]; maximum voltage equals input voltage.
 3. Unit Operating Requirements:
 - a. Internal Adjustability:
 - 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.
 - b. Self-Protection and Reliability Features:
 - 1) Surge suppression.
 - 2) Loss of input signal protection.
 - 3) Under- and overvoltage trips.
 - 4) Variable-frequency motor controller and motor-overload/overtemperature protection.
 - 5) Critical frequency rejection.

- 6) Loss-of-phase protection.
 - 7) Reverse-phase protection.
 - 8) Motor-overtemperature fault.
 - c. Bidirectional autospeed search.
 - d. Torque boost.
 - e. Motor temperature compensation at slow speeds.
 - 1) Panel-mounted operator station.
 - 2) Historical logging information and displays.
 - 3) Digital indicating devices.
 - f. Control Signal Interface: Electric.
 - g. Proportional Integral Directive (PID) control interface.
 - h. DDC system for HVAC Protocols for Network Communications: ASHRAE 135.
4. Line Conditioning:
- a. Input line conditioning.
 - b. Output filtering.
 - c. EMI/RFI filtering.
5. Bypass Systems:
- a. Bypass Mode: **[Manual operation only] [Field-selectable automatic or manual]**.
 - b. Bypass Controller, Two-Contactor Style: With bypass and output isolating contactors **[and isolating switch]**.
 - c. Bypass Controller, Three-Contactor Style: With bypass and input and output isolating contactors **[and isolating switch]**.
 - d. Bypass Contactor Configuration: **[Full-voltage (across the line)] [Reduced-voltage (autotransformer)] <Insert type>** type.

2.5 COIL SECTION

- A. General Requirements for Coil Section:
- 1. Comply with AHRI 410.
 - 2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - 3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
 - 4. Coils shall not act as structural component of unit.
- B. Preheat Coils:
- 1. Electrical Coils, Controls, and Accessories: Comply with UL 1995.
 - a. Casing Assembly: **[Slip-in] [Flanged]** type with galvanized-steel frame.
 - b. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
 - c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
 - d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
 - e. Control Panel: **[Unit] [Remote]** mounted with disconnecting means and overcurrent protection.
 - 1) **[Magnetic] [Mercury]** contactor.

- 2) Solid-state, stepless pulse controller.
 - 3) Toggle switches, one per step.
 - 4) Step controller.
 - 5) Time-delay relay.
 - 6) Pilot lights, one per step.
 - 7) Airflow proving switch.
2. Hot-Water Coils: [Continuous circuit] [Self-draining] [Cleanable].
 - a. Piping Connections: **[Threaded]** **[Flanged]**, **[same end]** **[opposite ends]** of coil.
 - b. Tube Material: Copper.
 - c. Fin Type: Plate.
 - d. Fin Material: **[Aluminum]** **[Copper]** **<Insert material>**.
 - e. Fin Spacing: Maximum **[10]** **[12]** **<Insert spacing>** fins per inch (mm).
 - f. Fin Thickness: **<Insert value>** inches (mm).
 - g. Fin and Tube Joint: **[Mechanical bond]** **[Silver brazed]**.
 - h. Headers:
 - 1) Cast iron with[cleaning plugs and] drain and air vent tappings[extended to exterior of unit].
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.
 - i. Frames: Channel frame, **[0.052-inch- (1.3-mm-)]** thick, galvanized steel] **[0.064-inch- (1.6-mm-)]** thick, galvanized steel] **[0.079-inch- (2.0-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, stainless steel] **<Insert thickness>** **<Insert material>**.
 - j. Coil Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
 - k. Coating: **[None]** **[Corrosion-resistant coating]**.
 - l. Integral Face-and-Bypass Dampers: **[Horizontal]** **[Vertical]**, opposed-blade, **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** dampers with **[zinc-plated]** steel operating rods rotating in sintered bronze or nylon bearings mounted in a single **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** frame, with operating rods connected with a common linkage. Meeting edges of blades shall have gaskets and edge seals, and blades shall be mechanically fastened.
3. Steam Coils: [Distributed] [Single tube].
 - a. Steam Outer-Tube Diameter: **<Insert value>** inches (mm).
 - b. Piping Connections: **[Threaded]** **[Flanged]**, **[same end]** **[opposite ends]** of coil.
 - c. Tube Material: Copper.
 - d. Fin Type: Plate.
 - e. Fin Material: **[Aluminum]** **[Copper]** **<Insert material>**.
 - f. Fin Spacing: Maximum **[8]** **[10]** **[12]** **<Insert spacing>** fins per inch (mm).
 - g. Fin Thickness: **<Insert value>** inches (mm).
 - h. Fin and Tube Joint: **[Mechanical bond]** **[Silver brazed]**.
 - i. Headers:
 - 1) Cast iron with[cleaning plugs and] drain and air vent tappings[extended to exterior of unit].
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.

- j. Frames: Channel frame, **[0.052-inch- (1.3-mm-)]** thick, galvanized steel] **[0.064-inch- (1.6-mm-)]** thick, galvanized steel] **[0.079-inch- (2.0-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, stainless steel] <Insert thickness> <Insert material>.
- k. Coil Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
- l. Coating: **[None]** **[Corrosion-resistant coating]**.
- m. Integral Face-and-Bypass Dampers: **[Horizontal]** **[Vertical]**, opposed-blade, **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** dampers with **[zinc-plated]** steel operating rods rotating in sintered bronze or nylon bearings mounted in a single **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** frame, with operating rods connected with a common linkage. Meeting edges of blades shall have gaskets and edge seals, and blades shall be mechanically fastened.

C. Heating Coils:

- 1. Electrical Coils, Controls, and Accessories: Comply with UL 1995.
 - a. Casing Assembly: **[Slip-in]** **[Flanged]** type with galvanized-steel frame.
 - b. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
 - c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
 - d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
 - e. Control Panel: **[Unit]** **[Remote]** mounted with disconnecting means and overcurrent protection.
 - 1) **[Magnetic]** **[Mercury]** contactor.
 - 2) Solid-state, stepless pulse controller.
 - 3) Toggle switches, one per step.
 - 4) Step controller.
 - 5) Time-delay relay.
 - 6) Pilot lights, one per step.
 - 7) Airflow proving switch.
- 2. Hot-Water Coils: **[Continuous circuit]** **[Self-draining]** **[Cleaning]**.
 - a. Piping Connections: **[Threaded]** **[Flanged]**, **[same end]** **[opposite ends]** of coil.
 - b. Tube Material: Copper.
 - c. Fin Type: Plate.
 - d. Fin Material: **[Aluminum]** **[Copper]** <Insert material>.
 - e. Fin Spacing: Maximum **[10]** **[12]** <Insert spacing> fins per inch (mm).
 - f. Fin Thickness: <Insert value> inches (mm).
 - g. Fin and Tube Joint: **[Mechanical bond]** **[Silver brazed]**.
 - h. Headers:
 - 1) Cast iron with[cleaning plugs and] drain and air vent tappings[extended to exterior of unit].
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.

- i. Frames: Channel frame, **[0.052-inch- (1.3-mm-)]** thick, galvanized steel] **[0.064-inch- (1.6-mm-)]** thick, galvanized steel] **[0.079-inch- (2.0-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, stainless steel] <Insert thickness> <Insert material>.
 - j. Coil Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
 - k. Coating: **[None]** **[Corrosion-resistant coating]**.
3. Steam Coils: **[Distributed]** **[Single tube]**.
- a. Steam Outer-Tube Diameter: <Insert value> inches (mm).
 - b. Piping Connections: **[Threaded]** **[Flanged]**, **[same end]** **[opposite ends]** of coil.
 - c. Tube Material: Copper.
 - d. Fin Type: Plate.
 - e. Fin Material: **[Aluminum]** **[Copper]** <Insert material>.
 - f. Fin Spacing: Maximum **[10]** **[12]** <Insert spacing> fins per inch (mm).
 - g. Fin Thickness: <Insert value> inches (mm).
 - h. Fin and Tube Joint: **[Mechanical bond]** **[Silver brazed]**.
 - i. Headers:
 - 1) Cast iron with[cleaning plugs and] drain and air vent tappings[extended to exterior of unit].
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.
 - j. Frames: Channel frame, **[0.052-inch- (1.3-mm-)]** thick, galvanized steel] **[0.064-inch- (1.6-mm-)]** thick, galvanized steel] **[0.079-inch- (2.0-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, stainless steel] <Insert thickness> <Insert material>.
 - k. Coil Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
 - l. Coating: **[None]** **[Corrosion-resistant coating]**.
- D. Cooling Coils:
1. Chilled-Water Coil: **[Continuous circuit]** **[Self-draining]** **[Cleanable]**.
- a. Piping Connections: **[Threaded]** **[Flanged]**, **[same end]** **[opposite ends]** of coil.
 - b. Tube Material: Copper.
 - c. Tube Thickness: <Insert value> inches (mm).
 - d. Fin Type: Plate.
 - e. Fin Material: **[Aluminum]** **[Copper]** <Insert material>.
 - f. Fin Spacing: **[0.125 inch (3.18 mm)]** **[0.091 inch (2.31 mm)]** **[0.071 inch (1.80 mm)]** **[0.067 inch (1.70 mm)]** **[0.056 inch (1.42 mm)]** **[0.0075 inch (0.19 mm)]** <Insert fins per inch (mm)>.
 - g. Fin Thickness: <Insert value> inches (mm).
 - h. Fin and Tube Joint: **[Mechanical bond]** **[Silver brazed]**.
 - i. Headers:
 - 1) Cast iron with[cleaning plugs and] drain and air vent tappings[extended to exterior of unit].
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.
 - j. Frames: Channel frame, **[0.052-inch- (1.3-mm-)]** thick, galvanized steel] **[0.064-inch- (1.6-mm-)]** thick, galvanized steel] **[0.079-inch- (2.0-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, galvanized steel] **[0.0625-inch- (1.58-mm-)]** thick, stainless steel].

- k. Coatings: **[None] [Corrosion-resistant coating]**.
- l. Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
- 2. Refrigerant Coil:
 - a. Tubes: Copper.
 - b. Fins:
 - 1) Material: [Aluminum] [Copper] <Insert material>.
 - 2) Fin Spacing: Maximum **[12] [10] [8] <Insert spacing>** fins per inch (mm).
 - c. Fin and Tube Joints: Mechanical bond.
 - d. Headers: **[Seamless-copper headers with brazed connections] <Insert material and connections>**.
 - e. Frames: **[Galvanized steel] [Stainless steel] <Insert material frame>**.
 - f. Coatings: **[None] [Corrosion-resistant coating]**.
 - g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - 1) Working Pressure: Minimum 300 psig (2070 kPa).

2.6 AIR FILTRATION SECTION

- A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
- B. High-efficiency particulate air (HEPA) filtration is specified in Section 234133 "High-Efficiency Particulate Air Filtration."
- C. Gas-phase air filtration is specified in Section 234200 "Gas-Phase Air Filtration."
- D. Panel Filters:
 - 1. Description: **[Flat, non-pleated] [Pleated]** factory-fabricated, self-supported, disposable air filters with holding frames.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive.
 - 4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.
- E. Bag Filters:
 - 1. Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames in steel, basket-type retainers.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Fibrous material, coated with antimicrobial agent, constructed so individual pockets are maintained in tapered form by flexible internal supports under rated-airflow conditions.
 - 4. Filter-Media Frame: Galvanized steel.
- F. Cartridge Filters:
 - 1. Description: Factory-fabricated, **[adhesive-coated]** disposable, packaged air filters with media perpendicular to airflow, and with holding frames.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Fibrous material, coated with antimicrobial agent, constructed so individual pleats are maintained in pleated form under rated-airflow conditions by corrugated aluminum separators.
 - 4. Filter Media Frame: Galvanized steel.
- G. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.

H. **[Front-] [or] [Back-]**Access Filter Mounting Frames:

1. Particulate Air Filter Frames: **[Galvanized-steel] [Aluminum]** framing members with access for filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
 - a. Prefilters: Incorporate a separate **[2-inch- (50-mm-)] <Insert dimension>** thick track **[with spring clips]**, with same access as primary filter.
 - b. Sealing: Full periphery foam gaskets.
2. HEPA Filter Frames: **[Aluminum] [Stainless-steel]** framing members, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation operation. Bolted filter-sealing mechanism shall mount and continuously seal each individual filter.
 - a. Prefilters: Incorporate a separate **[2-inch- (50-mm-)] [4-inch- (50-mm-)] <Insert dimension>** thick track **[with spring clips]** with same access as primary filter.
 - b. Sealing: **[Gasketed] [or] [gel]**, hand-crank locking mechanism to provide positive-sealing for each filter to ensure seal between filter elements to prevent bypass of unfiltered air.
3. Gas-Phase Air Filter Frames: **[Galvanized-steel] [Aluminum]** framing members with access for filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
 - a. Prefilters: Incorporate a separate **[2-inch- (50-mm-)] <Insert dimension>** thick track **[with spring clips]**.
 - b. Sealing: **[Full periphery foam gaskets] [Positive-sealing-device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air]**.

I. Side-Access Filter Mounting Frames:

1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. **[Galvanized steel] [Aluminum]** track.
 - a. Prefilters: Incorporate an integral **[2-inch- (50-mm-)] <Insert dimension>** thick track with same access as primary filter.
 - b. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.
2. HEPA Filter Frames:
 - a. Frames: Match inner casing and outer casing material, and insulation thickness. **[Aluminum] [Stainless steel]** track.
 - b. Prefilters: Incorporate an integral **[2-inch- (50-mm-)] [4-inch- (100-mm-)] <Insert dimension>** thick track,
 - c. Sealing: Incorporate positive-sealing clamping device on each filter between **[gasket] [gel]** seal on all sides of filter cartridge frames to prevent bypass of unfiltered air.
3. Gas-Phase Air Filter Frames:
 - a. Frames: Matching inner casing and outer casing material, and insulation thickness. **[Galvanized-steel] [Aluminum]** track.
 - b. Prefilters: Incorporate an integral **[2-inch- (50-mm-)] <Insert dimension>** thick track.

- c. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.7 DAMPERS

- A. Dampers: Comply with requirements in Section 230923.12 "Control Dampers."
- B. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** **<Insert material>** dampers with compressible jamb seals and extruded-vinyl blade edge seals in **[opposed]** **[parallel]**-blade arrangement with **[zinc-plated]** steel operating rods rotating in **[stainless steel sleeve]** **[sintered bronze or nylon]** **<Insert material>** bearings mounted in a single **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** **<Insert material>** frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed **[4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg ((1.0 MPa), leakage Class 1)]** **<Insert requirement>** **[, tested, rated, and labeled in accordance with AMCA 511]**.
- C. Face-and-Bypass Dampers: Opposed-blade, **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** dampers with **[zinc-plated]** steel operating rods rotating in sintered bronze or nylon bearings mounted in a single **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** frame and with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
- D. Zone Dampers: Two single-blade, **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** **<Insert materials>** dampers offset 90 degrees from each other on **[zinc-plated]** steel operating rod rotating in sintered bronze or nylon bearings mounted in a single **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** **<Insert material>** frame. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
- E. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
- F. Electronic Damper Operators:
 - 1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
 - 3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
 - 5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
 - 6. Size dampers for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.

- c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
 - e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
 7. Coupling: V-bolt and V-shaped, toothed cradle.
 8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
 10. Power Requirements (Two-Position Spring Return): 24 V dc.
 11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
 12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 13. Temperature Rating: **[Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)] [40 to 104 deg F (5 to 40 deg C)]**.
 14. Run Time: **[12 seconds open, 5 seconds closed] [30 seconds] [60 seconds] [120 seconds]**.
 - G. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
 - H. Combination Filter and Mixing Section:
 1. Cabinet support members shall hold **[2-inch- (50-mm-)] <Insert dimension>** thick, pleated, flat, permanent or throwaway filters.
 2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.
- ## 2.8 SOUND ATTENUATORS
- A. General Requirements:
 1. Factory fabricated.
 2. Fire Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials with flame-spread index not exceeding 25 and smoke-developed index not exceeding 50, ASTM E84.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with ASHRAE 62.1.
 - B. Shape: **[Rectangular, straight] [Round, straight] [Rectangular, elbow] [Round, elbow]**.
 - C. Rectangular Silencer Outer Casing: Galvanized steel.
 - D. Round Silencer Outer Casing: Galvanized steel.
 - E. Inner Casing and Baffles: Galvanized steel.
 - F. Principal Sound-Absorbing Mechanism:
 1. Packless Type: Controlled impedance membranes and broadly tuned resonators without adsorptive media.
 2. Dissipative Type: **[Polymer film-lined]** absorptive fill material.
 - a. Fill Material: Inert and vermin-proof fibrous material.
 3. Joints: Lock formed and sealed, continuously welded or flanged.

2.9 HUMIDIFIERS

- A. Direct-steam-injection humidifiers are specified in Section 238413.23 "Direct-Steam-Injection Humidifiers."
- B. Self-contained humidifiers are specified in Section 238413.29 "Self-Contained Humidifiers."
- C. Heat-exchanger humidifiers are specified in Section 238413.36 "Heat Exchanger Humidifiers."

2.10 AIR-TO-AIR ENERGY RECOVERY UNITS

A. Heat Wheels:

- 1. Casing:
 - a. Galvanized steel, stainless steel, or aluminum with manufacturer's standard finish.
 - b. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.5 percent at 400-Pa and 0.20 percent at 1000-Pa) differential pressure.
 - c. Casing seals on periphery of rotor, on duct divider, and on purge section.
 - d. Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.
- 2. Rotor, Aluminum or Polymer: Segmented wheel, strengthened with radial spokes[, **with nontoxic, noncorrosive, silica-gel desiccant coating**].
- 3. Rotor - Aluminum, Metallic, or Polymer: Segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, 3-angstrom molecular-sieve desiccant coating.
- 4. Drive: Fractional horsepower motor and gear reducer[, **with speed changed by variable-frequency controller**]. Permanently lubricated wheel bearings with an L-10 400,000 hours.
- 5. Controls:
 - a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 - b. Variable-frequency controller, factory mounted and wired, permitting input of field connected 4- to 20-mA or 1- to 10-V control signal.
 - c. Variable-frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
 - d. Variable-frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain **[exhaust temperature above freezing and]**air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
 - e. Pilot-Light Indicator: Display rotor rotation and speed.
 - f. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

B. Fixed-Plate Sensible Heat Exchangers:

- 1. Casing: **[Aluminum] [Galvanized steel] <Insert material>**.
- 2. Plates: Evenly spaced and sealed and arranged for **[counter] [cross]** airflow.
- 3. Plate Material: **[Embossed aluminum] [Stainless steel] [High-density plastic]**.
- 4. Plate Coating: Epoxy.
- 5. Bypass: Plenum within casing, with gasketed face-and-bypass dampers that have operating rods extended outside casing.
- 6. Heat-Exchanger Prefilters: **[1 inch (25 mm) thick, disposable] [2 inches (50 mm) thick, disposable] <Insert type> [MERV 6] <Insert MERV>**.

2.11 AIR BLENDERS

- A. Description: Static air mixer device to provide mixing of two airstreams to within plus/minus 6 deg F (3 deg C).
- B. Material: **[Galvanized steel] [Aluminum] <Insert material>**.
- C. Coating: **[None] [Corrosion-resistant coating]**.

2.12 DIFFUSERS

- A. Description: Velocity profile equalizer device for providing equalized airflow profile downstream of Type DWDI fans.
- B. Material: **[Galvanized steel] [Aluminum] <Insert material>**.

2.13 UV-C LAMP SYSTEMS

- A. Description:
 - 1. UV-C lamp system consisting of power supply, power supply housing, wiring, UV lamp(s), lamp plug, lamp plug protector, encapsulated lamp, and lamp holder used for UV germicidal irradiation of cooling coil and condensate drain pan.
 - 2. Factory installed and preengineered.
- B. Standard: UL Category Code ABQK, HVAC accessories, air-duct mounted.
- C. Lamps: High output, hot cathode.
- D. Lamp-Holder Construction:
 - 1. UV- and moisture-resistant materials and designed to connect the lamp to the plug.
 - 2. Adjustable positioning.
- E. Lamp-Clamp Construction:
 - 1. UV- and moisture-resistant materials, water-tight connection.
 - 2. Adjustable positioning.
- F. Lamp Protection: Hermetically sealed to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.
- G. Lamp Output: UV-C energy, primarily at the 254-nm wavelength with a 360-degree energy distribution.
- H. Access Door Interlocks: Automatic disconnect on all access doors into UV-installed casing sections to shield servicing personnel from contact with light.
- I. Power Supply: UL-listed, single-point electrical connection[**with service disconnect**].
- J. Power Consumption: Maximum of **[15 W/sq. ft. (161 W/sq. m)] <Insert value>**.

2.14 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B 09 (ASTM B209M).
- E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
- F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
 - c. ASTM B3359 for cross hatch adhesion of 5B.
 - 2. Application: Spray.
 - 3. Thickness: 1 mil (0.025 mm).
 - 4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.15 SOURCE QUALITY CONTROL

- A. AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.
- B. AHRI 1060 Certification: Test, rate, and label air-handling units that include air-to-air energy recovery devices in accordance with AHRI 1060.
- C. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.
- D. Fan Aerodynamic Performance Rating: Factory test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.
- E. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.
- F. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.
- G. Water Coils: Factory tested to 300 psig (2070 kPa) according to AHRI 410 and ASHRAE 33.
- H. Steam Coils: Factory tested to 300 and 200 psig (2070 and 1380 kPa) underwater according to AHRI 410 and ASHRAE 33.
- I. Refrigerant Coils: Factory tested to minimum 450-psig (3105-kPa) internal pressure and to minimum 300-psig (2070-kPa) internal pressure while underwater, according to AHRI 410 and ASHRAE 33.
- J. Witnessed Casing Leakage Tests:
 - 1. Pay for all expenses, for one representative designated by Owner, to travel to the factory to witness cabinet air-leakage testing on the specific assembled unit(s) prior to release for delivery to Project site.
 - 2. If the unit(s) does not meet specified leakage requirements, perform factory modifications and retest. Do not release unit for shipment until tested leakage is measured to be within specified leakage and leakage testing report has been accepted by Owner's designated representative.

PART 3 - EXECUTION – NOT USED

END OF SECTION 237313.16

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SECTION 237343.16 - OUTDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following:
 - 1. Adhesives: VOC content and emissions evaluation.
 - 2. Sealants: VOC content and emissions evaluation.
- 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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[, **supports**,] and seismic restraints], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- G. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."
- H. Structural Performance:
 - 1. Casing Panels: Self-supporting and capable of withstanding positive/negative 8-inch wg (2000-Pa) internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch (0.0042 mm/mm) of panel span.
 - 2. Floor and Roof Panels: Self-supporting and capable of withstanding 300-lb (136-kg) static load at midspan, without exceeding a midpoint deflection of 0.0042 inch/inch (0.0042 mm/mm).
 - 3. Roof Panels: Self-supporting and capable of withstanding a static snow load of 30 lb/sq. ft. (146 kg/sq. m), without exceeding a midpoint deflection of 0.0042 inch/inch (0.0042 mm/mm).
- I. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8-inch wg (2000 Pa).

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corporation; a unit of United Technologies Corp.
 - 2. Coil Company, LLC.
 - 3. Daikin Applied.
 - 4. Dunham-Bush, Inc.
 - 5. Trane.

6. USA Coil & Air.
7. YORK; a Johnson Controls company.
8. Energy Labs.

B. Source Limitations: Obtain from single source from single manufacturer.

2.3 UNIT CASINGS

- A. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.
- B. Base Rail:
1. Material: **[Galvanized steel] [Welded structural steel] <Insert material>.**
 2. Height: **[6 inches (150 mm)] <Insert dimension>.**
- C. Casing Joints: Hermetically sealed at each corner and around entire perimeter.
- D. Double-Wall Construction:
1. Outside Casing Wall:
 - a. Material, Galvanized Steel: Minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] [14 gauge (2.0 mm)] <Insert value> thick.**
 - b. Material, Aluminum: Minimum **[16 gauge (1.3 mm)] [14 gauge (1.6 mm)] [12 gauge (2.0 mm)] <Insert value> thick.**
 - c. Material, Stainless Steel: Minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] [14 gauge (2.0 mm)] <Insert value> thick.**
 - d. Factory Finish: Provide **[manufacturer's standard finish] [corrosion-resistant coating] <Insert special coating>.**
 2. Inside Casing Wall:
 - a. Material, Galvanized Steel: **[Solid] [Perforated]**, minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] <Insert value> thick.**
 - b. Material, Aluminum: **[Solid] [Perforated]**, minimum **[16 gauge (1.3 mm)] [14 gauge (1.6 mm)] <Insert value> thick.**
 - c. Material, Stainless Steel: **[Solid] [Perforated]**, minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] <Insert value> thick.**
 - d. Antimicrobial Coating: Applied during the manufacturing process. **[EPA approved] [NSF approved] [FDA listed].**
- E. Floor Plate:
1. Material:
 - a. Galvanized steel, **[treadplate,]** minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] [14 gauge (2.0 mm)] [12 gauge (2.7 mm)] [10 gauge (3.5 mm)] <Insert value> thick.**
 - b. Aluminum, **[treadplate,]** minimum **[18 gauge (1.0 mm)] [16 gauge (1.3 mm)] [14 gauge (1.6 mm)] [12 gauge (2.0 mm)] [10 gauge (2.6 mm)] <Insert value> thick.**
 - c. Stainless steel, **[treadplate,]** minimum **[18 gauge (1.3 mm)] [16 gauge (1.6 mm)] [14 gauge (2.0 mm)] [12 gauge (2.8 mm)] [10 gauge (3.5 mm)] <Insert value> thick.**
 2. Antimicrobial Coating: Applied during the manufacturing process. **[EPA approved] [NSF approved] [FDA listed].**
- F. Roof: Cross-braken and pitched with "C" caps over joints to provide watertight seal.

- G. Piping Vestibule: Insulated with same insulation and thickness as casing, [**18 inches (450 mm)**] [**24 inches (600 mm)**] [**30 inches (750 mm)**] <Insert dimension> deep by full width of piping connections.
- H. Casing Insulation:
 - 1. Materials: [**Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071**] [**or**] [**injected polyurethane foam insulation**].
 - 2. Casing Panel R-Value: Minimum [**R-6.5**] [**R-11**] [**R-13**] <Insert value>.
 - 3. Insulation Thickness: [**1 inches (25 mm)**] [**2 inches (50 mm)**] <Insert dimension>.
 - 4. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
- I. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- J. Static-Pressure Classifications:
 - 1. For Unit Sections Upstream of Fans: Minus [**2-inch wg (500 Pa)**] [**3-inch wg (750 Pa)**] [**4-inch wg (1000 Pa)**] [**6-inch wg (1500 Pa)**] <Insert value>.
 - 2. For Unit Sections Downstream and Including Fans: [**2-inch wg (500 Pa)**] [**3-inch wg (750 Pa)**] [**4-inch wg (1000 Pa)**] [**6-inch wg (1500 Pa)**] <Insert value>.
- K. Panels, Doors, and Windows:
 - 1. Panels:
 - a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least [**18 inches (450 mm)**] [**24 inches (600 mm)**] <Insert dimension> wide by full height of unit casing up to a maximum height of [**60 inches (1500 mm)**] [**72 inches (1800 mm)**] <Insert dimension>.
 - 2. Doors:
 - a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least [**18 inches (450 mm)**] [**24 inches (600 mm)**] <Insert dimension> wide by full height of unit casing up to a maximum height of [**60 inches (1500 mm)**] [**72 inches (1800 mm)**] <Insert dimension>.
 - 3. Windows:
 - a. Construction: Fabricate windows in access panels and doors of double-glazed, safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
 - b. Size: Minimum 6 inches (150 mm), square or round.

4. Locations and Applications:
 - a. Fan Section: Doors[, **with windows**].
 - b. Coil Section: Panels.
 - c. Access Section: Doors[, **with windows**].
 - d. Access Sections Immediately Upstream and Downstream of Coil Sections: Doors[, **with windows**].
 - e. Damper Section: Doors[, **with windows**].
 - f. Filter Section: [**Doors**] [**Panels**] large enough to allow periodic removal and installation of filters.
 - g. Access Sections Immediately [**Upstream**] [**and**] [**Downstream**] of Filter Sections: [**Doors**] [**Panels**] [, **with windows**].
 - h. Mixing Section: [**Doors**] [**Panels**] [, **with windows**].
 - i. Humidifier Section: [**Doors**] [**Panels**] [, **with windows**].
5. Service Lights: LED vaporproof luminaire with individual switched junction box located [**outside**] [**inside**], adjacent to each access door and panel.
 - a. Locations: [**Each section accessed with door or panel**] [**Fan section**] <Insert location>.
6. Convenience Outlets: One 20-A duplex GFCI receptacle per location with junction box located on outside casing wall.
 - a. Locations: [**Each section accessed with a door or panel**] [**Fan section**] <Insert location>.
- L. Condensate Drain Pans:
 1. Location: Each type of [**cooling coil**] [**heat wheel**].
 2. Construction:
 - a. Single-wall, stainless-steel sheet.
 - b. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 3. Drain Connection:
 - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on [**one end**] [**both ends**] of pan.
 - b. Minimum Connection Size: [**NPS 1 (DN 25)**] [**NPS 2 (DN 50)**] <Insert pipe size>.
 4. Slope: Minimum 0.125-in./ft. (10-mm/mm) slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
 6. Width: Entire width of water producing device.
 7. Depth: A minimum of 2 inches (50 mm) deep.
 8. [**Formed sections**] [**Integral part of floor plating**].
 9. Provide splash guard at chilled water coil section if used.
 10. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
 11. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.4 FAN, DRIVE, AND MOTOR SECTION

Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

- A. Direct Drive Fans preferred to belt drive in most instances.
- B. Fans: Centrifugal, galvanized steel; mounted on solid-steel shaft.
 - 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 - 2. Shaft Bearings:
 - a. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L-50 rated life of 200,000 hours according to ABMA 9.
 - b. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and two-piece, cast-iron housing[**with grease lines extended to outside unit**] and an L-50 rated life of 200,000 hours according to ABMA 11.
 - c. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing[**with grease lines extended to outside unit**] and an L-50 rated life of 200,000.
 - 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 4. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
 - 5. Plenum Fan Arrays: [**Contained**] [**Uncontained**] as defined in AHRI 430. Steel or aluminum frame with inlet cone and structural framing around each fan built into an array of multiple fans. Provide [**backdraft**] [**motorized**] dampers at each fan to prevent short circuiting of flow if one fan is not operating.
 - 6. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; [**steel**] [**aluminum**] hub riveted to backplate and fastened to shaft with setscrews.
 - 7. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; [**steel**] [**aluminum**] hub swaged to backplate and fastened to shaft with setscrews.
 - 8. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
 - 9. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of [**1 inch (25 mm)**] [**2 inches (50 mm)**] <Insert dimension>.
 - 10. Shaft Lubrication Lines: Extended to a location outside the casing.
 - 11. Flexible Connector: Factory fabricated with a fabric strip minimum [**3-1/2 inches (89 mm)**] [**5-3/4 inches (146 mm)**] <Insert dimension> wide, attached to two strips of minimum [**2-3/4-inch- (70-mm-)wide**] <Insert width> by [**0.028-inch- (0.7-mm-) thick, galvanized-steel sheet**] [**0.032-inch- (0.8-mm-) thick, aluminum sheets**].
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
 - 1) Fabric Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).

- 2) Fabric Minimum Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3) Fabric Minimum Service Temperature Range: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
- C. Drive, Direct: Factory-mounted, direct drive.
- D. Drive, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
 2. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
 3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch- (2.7-mm-) thick, 3/4-inch (20-mm) diamond-mesh wire screen, welded to steel angle frame; prime coated.
- E. Motors:
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 3. Enclosure Type: **[Open, dripproof] [Totally enclosed, fan cooled] <Insert type>**.
 4. Enclosure Materials: Cast iron.
 5. Motor Bearings: **<Insert requirements>**.
 6. Unusual Service Conditions:
 - a. Ambient Temperature: **<Insert deg C>**.
 - b. Altitude: **<Insert feet (m)>** above sea level.
 - c. High humidity.
 - d. **<Insert conditions>**.
 7. Efficiency: Premium efficient as defined in NEMA MG 1.
 8. NEMA Design: **<Insert designation>**.
 9. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
 10. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 11. **<Insert unique motor characteristics>**.
 12. Mount unit-mounted disconnect switches on **[exterior] [interior]** of unit.
- F. Comply with Section 262923 "Variable-Frequency Motor Controllers."
- G. Variable-Frequency Motor Controller: Serving **[each fan individually] [all fans combined]** in fan array.
1. Manufactured Units: Pulse-width modulated; **[constant torque] [and] [variable torque] <Insert application>** for **[Design A and Design B] [inverter-duty]** motors.
 2. Output Rating: Three phase; 10 to **[60 Hz, with voltage proportional to frequency throughout voltage range] [66 Hz, with torque constant as speed changes]**; maximum voltage equals input voltage.
 3. Unit Operating Requirements:
 - a. Internal Adjustability:
 - 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.
 - b. Self-Protection and Reliability Features:
 - 1) Surge suppression.
 - 2) Loss of input signal protection.
 - 3) Under- and overvoltage trips.
 - 4) Variable-frequency motor controller and motor-overload/overtemperature protection.
 - 5) Critical frequency rejection.
 - 6) Loss-of-phase protection.
 - 7) Reverse-phase protection.
 - 8) Motor-overtemperature fault.
 - c. Bidirectional autospeed search.
 - d. Torque boost.
 - e. Motor temperature compensation at slow speeds.
 - 1) Panel-mounted operator station.
 - 2) Historical logging information and displays.
 - 3) Digital indicating devices.
 - f. Control Signal Interface: Electric.
 - g. Proportional Integral Directive (PID) control interface.
 - h. DDC system for HVAC Protocols for Network Communications: ASHRAE 135.
4. Line Conditioning:
 - a. Input line conditioning.
 - b. Output filtering.
 - c. EMI/RFI filtering.
5. Bypass Systems:
 - a. Bypass Mode: **[Manual operation only] [Field-selectable automatic or manual]**.
 - b. Bypass Controller, Two-Contactor Style: With bypass and output isolating contactors[**and isolating switch**].
 - c. Bypass Controller, Three-Contactor Style: With bypass and input and output isolating contactors[**and isolating switch**].
 - d. Bypass Contactor Configuration: **[Full-voltage (across the line)] [Reduced-voltage (autotransformer)]** <Insert type> type.

2.5 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with AHRI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.

B. Preheat Coils:

1. Electrical Coils, Controls, and Accessories: Comply with UL 1995.
 - a. Casing Assembly: **[Slip-in] [Flanged]** type with galvanized-steel frame.

- b. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
 - c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
 - d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
 - e. Control Panel: **[Unit]** **[Remote]** mounted with disconnecting means and overcurrent protection.
 - 1) **[Magnetic]** **[Mercury]** contactor.
 - 2) Solid-state, stepless pulse controller.
 - 3) Toggle switches, one per step.
 - 4) Step controller.
 - 5) Time-delay relay.
 - 6) Pilot lights, one per step.
 - 7) Airflow proving switch.
2. Hot-Water Coils; **[Continuous circuit]** **[Self-draining]** **[Cleanable]**.
- a. Piping Connections: **[Threaded]** **[Flanged]**, **[same end]** **[opposite ends]** of coil.
 - b. Tube Material: Copper.
 - c. Fin Type: Plate.
 - d. Fin Material: **[Aluminum]** **[Copper]** **<Insert material>**.
 - e. Fin Spacing: Maximum **[10]** **[12]** **<Insert spacing>** fins per inch (mm).
 - f. Fin Thickness: **<Insert value>** inches (mm).
 - g. Fin and Tube Joint: **[Mechanical bond]** **[Silver brazed]**.
 - h. Headers:
 - 1) Cast iron with **[cleaning plugs and]** drain and air vent tappings **[extended to exterior of unit]**.
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.
 - i. Frames: Channel frame, **[0.052-inch- (1.3-mm-) thick, galvanized steel]** **[0.064-inch- (1.6-mm-) thick, galvanized steel]** **[0.079-inch- (2.0-mm-) thick, galvanized steel]** **[0.0625-inch- (1.58-mm-) thick, galvanized steel]** **[0.0625-inch- (1.58-mm-) thick, stainless steel]** **<Insert thickness>** **<Insert material>**.
 - j. Coil Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
 - k. Coating: **[None]** **[Corrosion-resistant coating]**.
 - l. Integral Face-and-Bypass Dampers: **[Horizontal]** **[Vertical]**, opposed-blade, **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** dampers with **[zinc-plated]** steel operating rods rotating in sintered bronze or nylon bearings mounted in a single **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** frame, with operating rods connected with a common linkage. Meeting edges of blades shall have gaskets and edge seals, and blades shall be mechanically fastened.
3. Steam Coils: **[Distributed]** **[Single tube]**.
- a. Steam Outer-Tube Diameter: **<Insert value>** inches (mm).
 - b. Piping Connections: **[Threaded]** **[Flanged]**, **[same end]** **[opposite ends]** of coil.
 - c. Tube Material: Copper.
 - d. Fin Type: Plate.
 - e. Fin Material: **[Aluminum]** **[Copper]** **<Insert material>**.

- f. Fin Spacing: Maximum [8] [10] [12] <Insert spacing> fins per inch (mm).
- g. Fin Thickness: <Insert value> inches (mm).
- h. Fin and Tube Joint: [Mechanical bond] [Silver brazed].
- i. Headers:
 - 1) Cast iron with[cleaning plugs and] drain and air vent tappings[extended to exterior of unit].
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.
- j. Frames: Channel frame, [0.052-inch- (1.3-mm-) thick, galvanized steel] [0.064-inch- (1.6-mm-) thick, galvanized steel] [0.079-inch- (2.0-mm-) thick, galvanized steel] [0.0625-inch- (1.58-mm-) thick, galvanized steel] [0.0625-inch- (1.58-mm-) thick, stainless steel] <Insert thickness> <Insert material>.
- k. Coil Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
- l. Coating: [None] [Corrosion-resistant coating].
- m. Integral Face-and-Bypass Dampers: [Horizontal] [Vertical], opposed-blade, [galvanized-steel] [aluminum] [extruded-aluminum] dampers with [zinc-plated] steel operating rods rotating in sintered bronze or nylon bearings mounted in a single [galvanized-steel] [aluminum] [extruded-aluminum] frame, with operating rods connected with a common linkage. Meeting edges of blades shall have gaskets and edge seals, and blades shall be mechanically fastened.

C. Heating Coils:

- 1. Electrical Coils, Controls, and Accessories: Comply with UL 1995.
 - a. Casing Assembly: [Slip-in] [Flanged] type with galvanized-steel frame.
 - b. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
 - c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
 - d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
 - e. Control Panel: [Unit] [Remote] mounted with disconnecting means and overcurrent protection.
 - 1) [Magnetic] [Mercury] contactor.
 - 2) Solid-state, stepless pulse controller.
 - 3) Toggle switches, one per step.
 - 4) Step controller.
 - 5) Time-delay relay.
 - 6) Pilot lights, one per step.
 - 7) Airflow proving switch.
- 2. Hot-Water Coils: [Continuous circuit] [Self-draining] [Cleaning].
 - a. Piping Connections: [Threaded] [Flanged], [same end] [opposite ends] of coil.
 - b. Tube Material: Copper.
 - c. Fin Type: Plate.
 - d. Fin Material: [Aluminum] [Copper] <Insert material>.
 - e. Fin Spacing: Maximum [10] [12] <Insert spacing> fins per inch (mm).
 - f. Fin Thickness: <Insert value> inches (mm).
 - g. Fin and Tube Joint: [Mechanical bond] [Silver brazed].

- h. Headers:
 - 1) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.
 - i. Frames: Channel frame, [0.052-inch- (1.3-mm-) thick, galvanized steel] [0.064-inch- (1.6-mm-) thick, galvanized steel] [0.079-inch- (2.0-mm-) thick, galvanized steel] [0.0625-inch- (1.58-mm-) thick, galvanized steel] [0.0625-inch- (1.58-mm-) thick, stainless steel] <Insert thickness> <Insert material>.
 - j. Coil Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
 - k. Coating: [None] [Corrosion-resistant coating].
3. Steam Coils: [Distributed] [Single tube].
- a. Steam Outer-Tube Diameter: <Insert value> inches (mm).
 - b. Piping Connections: [Threaded] [Flanged], [same end] [opposite ends] of coil.
 - c. Tube Material: Copper.
 - d. Fin Type: Plate.
 - e. Fin Material: [Aluminum] [Copper] <Insert material>.
 - f. Fin Spacing: Maximum [10] [12] <Insert spacing> fins per inch (mm).
 - g. Fin Thickness: <Insert value> inches (mm).
 - h. Fin and Tube Joint: [Mechanical bond] [Silver brazed].
 - i. Headers:
 - 1) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.
 - j. Frames: Channel frame, [0.052-inch- (1.3-mm-) thick, galvanized steel] [0.064-inch- (1.6-mm-) thick, galvanized steel] [0.079-inch- (2.0-mm-) thick, galvanized steel] [0.0625-inch- (1.58-mm-) thick, galvanized steel] [0.0625-inch- (1.58-mm-) thick, stainless steel] <Insert thickness> <Insert material>.
 - k. Coil Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
 - l. Coating: [None] [Corrosion-resistant coating].
- D. Cooling Coils:
1. Chilled-Water Coil: [Continuous circuit] [Self-draining] [Cleanable].
- a. Piping Connections: [Threaded] [Flanged], [same end] [opposite ends] of coil.
 - b. Tube Material: Copper.
 - c. Tube Thickness: <Insert value> inches (mm).
 - d. Fin Type: Plate.
 - e. Fin Material: [Aluminum] [Copper] <Insert material>.
 - f. Fin Spacing: [0.125 inch (3.18 mm)] [0.091 inch (2.31 mm)] [0.071 inch (1.80 mm)] [0.067 inch (1.70 mm)] [0.056 inch (1.42 mm)] [0.0075 inch (0.19 mm)] <Insert fins per inch (mm)>.
 - g. Fin Thickness: <Insert value> inches (mm).
 - h. Fin and Tube Joint: [Mechanical bond] [Silver brazed].
 - i. Headers:
 - 1) Cast iron with[**cleaning plugs and**] drain and air vent tappings[**extended to exterior of unit**].
 - 2) Seamless copper tube with brazed joints, prime coated.

- 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.
 - j. Frames: Channel frame, **[0.052-inch- (1.3-mm-) thick, galvanized steel] [0.064-inch- (1.6-mm-) thick, galvanized steel] [0.079-inch- (2.0-mm-) thick, galvanized steel] [0.0625-inch- (1.58-mm-) thick, galvanized steel] [0.0625-inch- (1.58-mm-) thick, stainless steel]**.
 - k. Coatings: **[None] [Corrosion-resistant coating]**.
 - l. Working-Pressure Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
2. Refrigerant Coil:
- a. Tubes: Copper.
 - b. Fins:
 - 1) Material: **[Aluminum] [Copper] <Insert material>**.
 - 2) Fin Spacing: Maximum **[12] [10] [8] <Insert spacing>** fins per inch (mm).
 - c. Fin and Tube Joints: Mechanical bond.
 - d. Headers: **[Seamless-copper headers with brazed connections] <Insert material and connections>**.
 - e. Frames: **[Galvanized steel] [Stainless steel] <Insert material frame>**.
 - f. Coatings: **[None] [Corrosion-resistant coating]**.
 - g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - 1) Working Pressure: Minimum 300 psig (2070 kPa).

2.6 AIR FILTRATION SECTION

- A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
- B. High-efficiency particulate air (HEPA) filtration is specified in Section 234133 "High-Efficiency Particulate Air Filtration."
- C. Gas-phase air filtration is specified in Section 234200 "Gas-Phase Air Filtration."
- D. Panel Filters:
 - 1. Description: **[Flat, non-pleated] [Pleated]** factory-fabricated, self-supported, disposable air filters with holding frames.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive.
 - 4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.
- E. Bag Filters:
 - 1. Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames in steel, basket-type retainers.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Fibrous material, coated with antimicrobial agent, constructed so individual pockets are maintained in tapered form by flexible internal supports under rated-airflow conditions.
 - 4. Filter-Media Frame: Galvanized steel.
- F. Cartridge Filters:
 - 1. Description: Factory-fabricated, **[adhesive-coated]** disposable, packaged air filters with media perpendicular to airflow, and with holding frames.
 - 2. Filter Unit Class: UL 900.

3. Media: Fibrous material, coated with antimicrobial agent, constructed so individual pleats are maintained in pleated form under rater-airflow conditions by corrugated aluminum separators.
4. Filter Media Frame: Galvanized steel.
- G. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
- H. **[Front-] [or] [Back-]**Access Filter Mounting Frames:
 1. Particulate Air Filter Frames: **[Galvanized-steel] [Aluminum]** framing members with access for filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
 - a. Prefilters: Incorporate a separate **[2-inch- (50-mm-)] <Insert dimension>** thick track **[with spring clips]**, with same access as primary filter.
 - b. Sealing: Full periphery foam gaskets.
 2. HEPA Filter Frames: **[Aluminum] [Stainless-steel]** framing members, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation operation. Bolted filter-sealing mechanism shall mount and continuously seal each individual filter.
 - a. Prefilters: Incorporate a separate **[2-inch- (50-mm-)] [4-inch- (50-mm-)] <Insert dimension>** thick track **[with spring clips]** with same access as primary filter.
 - b. Sealing: **[Gasketed] [or] [gel]**, hand-crank locking mechanism to provide positive-sealing for each filter to ensure seal between filter elements to prevent bypass of unfiltered air.
 3. Gas-Phase Air Filter Frames: **[Galvanized-steel] [Aluminum]** framing members with access for filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
 - a. Prefilters: Incorporate a separate **[2-inch- (50-mm-)] <Insert dimension>** thick track **[with spring clips]**.
 - b. Sealing: **[Full periphery foam gaskets] [Positive-sealing-device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air]**.
- I. Side-Access Filter Mounting Frames:
 1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. **[Galvanized steel] [Aluminum]** track.
 - a. Prefilters: Incorporate an integral **[2-inch- (50-mm-)] <Insert dimension>** thick track with same access as primary filter.
 - b. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.
 2. HEPA Filter Frames:
 - a. Frames: Match inner casing and outer casing material, and insulation thickness. **[Aluminum] [Stainless steel]** track.
 - b. Prefilters: Incorporate an integral **[2-inch- (50-mm-)] [4-inch- (100-mm-)] <Insert dimension>** thick track,

- c. Sealing: Incorporate positive-sealing clamping device on each filter between **[gasket]** **[gel]** seal on all sides of filter cartridge frames to prevent bypass of unfiltered air.
- 3. Gas-Phase Air Filter Frames:
 - a. Frames: Matching inner casing and outer casing material, and insulation thickness. **[Galvanized-steel]** **[Aluminum]** track.
 - b. Prefilters: Incorporate an integral **[2-inch- (50-mm-)]** **<Insert dimension>** thick track.
 - c. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.7 DAMPERS

- A. Dampers: Comply with requirements in Section 230923.12 "Control Dampers."
- B. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** **<Insert material>** dampers with compressible jamb seals and extruded-vinyl blade edge seals in **[opposed]** **[parallel]**-blade arrangement with **[zinc-replated]** steel operating rods rotating in **[stainless steel sleeve]** **[sintered bronze or nylon]** **<Insert material>** bearings mounted in a single **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** **<Insert material>** frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed **[4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa), leakage Class 1]** **<Insert requirement>** **[, tested, rated, and labeled in accordance with AMCA 511]**.
- C. Face-and-Bypass Dampers: Opposed-blade, **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** dampers with **[zinc-plated]** steel operating rods rotating in sintered bronze or nylon bearings mounted in a single **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** frame and with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
- D. Zone Dampers: Two single-blade, **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** **<Insert materials>** dampers offset 90 degrees from each other on **[zinc-plated]** steel operating rod rotating in sintered bronze or nylon bearings mounted in a single **[galvanized-steel]** **[aluminum]** **[extruded-aluminum]** **<Insert material>** frame. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod
- E. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
- F. Electronic Damper Operators:
 - 1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
 - 3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
 5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
 6. Size dampers for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
 - e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
 7. Coupling: V-bolt and V-shaped, toothed cradle.
 8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
 10. Power Requirements (Two-Position Spring Return): **[24 V dc] [120 V ac] [230 V ac]**.
 11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
 12. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 13. Temperature Rating: **[Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)] [40 to 104 deg F (5 to 40 deg C)]**.
 14. Run Time: **[12 seconds open, 5 seconds closed] [30 seconds] [60 seconds] [120 seconds]**.
- G. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
- H. Combination Filter and Mixing Section:
1. Cabinet support members shall hold **[2-inch- (50-mm-)] <Insert dimension>** thick, pleated, flat, permanent or throwaway filters.
 2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.8 SOUND ATTENUATORS

- A. General Requirements:
1. Factory fabricated.
 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials with flame-spread index not exceeding 25 and smoke-developed index not exceeding 50; ASTM E84.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with ASHRAE 62.1.
- B. Shape: **[Rectangular, straight] [Round, straight] [Rectangular, elbow] [Round, elbow]**.
- C. Rectangular Silencer Outer Casing: **[Galvanized steel] <Insert material>**.
- D. Round Silencer Outer Casing: **[Galvanized steel] <Insert material>**.

- E. Inner Casing and Baffles: [**Galvanized steel**] <Insert material>.
- F. Principal Sound-Absorbing Mechanism:
 - 1. Packless Type: Controlled impedance membranes and broadly tuned resonators without adsorptive media.
 - 2. Dissipative Type: [**Polymer film-lined**] absorptive fill material.
 - a. Fill Material: [**Inert and vermin-proof fibrous material**] <Insert material type>.
 - 3. Joints: Lock formed and sealed, continuously welded or flanged.

2.9 HUMIDIFIERS

- A. Direct-steam-injection humidifiers are specified in Section 238413.23 "Direct-Steam-Injection Humidifiers."
- B. Self-contained humidifiers are specified in Section 238413.29 "Self-Contained Humidifiers."
- C. Heat-exchanger humidifiers are specified in Section 238413.36 "Heat Exchanger Humidifiers."

2.10 AIR-TO-AIR ENERGY RECOVERY UNITS

- A. Heat Wheels:
 - 1. Casing:
 - a. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory finish.
 - b. Integral purge section limiting carryover of exhaust air to between [**0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.5 percent at 400-Pa and 0.20 percent at 1000-Pa)**] <Insert values> differential pressure.
 - c. Casing seals on periphery of rotor, on duct divider, and on purge section.
 - d. Support vertical rotors on grease-lubricated ball bearings with extended grease fittings. Mount horizontal rotors on tapered roller bearing.
 - 2. Rotor, Aluminum or Polymer: Segmented wheel, strengthened with radial spokes[, **with nontoxic, noncorrosive, silica-gel desiccant coating**].
 - 3. Rotor - Aluminum, Metallic, or Polymer: Segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, 3-angstrom molecular-sieve desiccant coating.
 - 4. Drive: Fractional horsepower motor and gear reducer[, **with speed changed by variable-frequency controller**]. Permanently lubricated wheel bearings with an L-10 400,000 hours.
 - 5. Controls:
 - a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 - b. Variable-frequency controller, factory mounted and wired, permitting input of field connected 4- to 20-mA or 1- to 10-V control signal.
 - c. Variable-frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
 - d. Variable-frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain [**exhaust temperature above freezing and**] air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
 - e. Pilot-Light Indicator: Display rotor rotation and speed.
 - f. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

B. Fixed-Plate Sensible Heat Exchangers:

1. Casing: **[Aluminum] [Galvanized steel] <Insert material>**.
2. Plates: Evenly spaced and sealed and arranged for **[counter] [cross]** airflow.
3. Plate Material: **[Embossed aluminum] [Stainless steel] [High-density plastic]**.
4. Plate Coating: **[Epoxy] <Insert coating>**.
5. Bypass: Plenum within casing, with gasketed face-and-bypass dampers that have operating rods extended outside casing.
6. Heat-Exchanger Prefilters:
 - a. Thickness: **[1 inch (25 mm) thick, disposable] [2 inches (50 mm) thick, disposable] <Insert type>**.
 - b. MERV Rating: **[MERV 6] <Insert MERV rating>**.

2.11 AIR BLENDERS

- A. Description: Static air mixer device to provide mixing of two airstreams to within **[plus/minus 6 deg F (3 deg C)] <Insert mixing differential>**.
- B. Material: **[Galvanized steel] [Aluminum] <Insert material>**.
- C. Coating: **[None] [Corrosion-resistant coating]**.

2.12 DIFFUSERS

- A. Description: Velocity profile equalizer device for providing equalized airflow profile downstream of Type DWDI fans.
- B. Material: **[Galvanized steel] [Aluminum] <Insert material>**.

2.13 UV-C LAMP SYSTEMS

- A. Description:
 1. UV-C lamp system consisting of power supply, power supply housing, wiring, UV lamp(s), lamp plug, lamp plug protector, encapsulated lamp, and lamp holder used for UV germicidal irradiation of cooling coil and condensate drain pan.
 2. Factory installed and preengineered.
- B. Standard: UL Category Code ABQK, HVAC accessories, air-duct mounted.
- C. Lamps: High output, hot cathode.
- D. Lamp-Holder Construction:
 1. UV- and moisture-resistant materials and designed to connect the lamp to the plug.
 2. Adjustable positioning.
- E. Lamp-Clamp Construction:
 1. UV- and moisture-resistant materials, water-tight connection.
 2. Adjustable positioning.
- F. Lamp Protection: Hermetically sealed to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.
- G. Lamp Output: UV-C energy, primarily at the 254-nm wavelength with a 360-degree energy distribution.
- H. Access Door Interlocks: Automatic disconnect on all access doors into UV-installed casing sections to shield servicing personnel from contact with light.
- I. Power Supply: UL-listed, single-point electrical connection[**with service disconnect**].

- J. Power Consumption: Maximum of **[15 W/sq. ft. (161 W/sq. m)] <Insert value>**.

2.14 ROOF CURBS

- A. Roof curbs with vibration isolators **[and] [wind] [or] [seismic]** restraints are specified in **[Section 230548 "Vibration and Seismic Controls for HVAC."]** **[Section 230548.13 "Vibration Controls for HVAC."]**
- B. Materials: Galvanized steel with corrosion-resistant coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C1071, Type I or II.
 - b. Thickness: **[1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension>**.
 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
- C. Curb Dimensions: Height of **[14 inches (355 mm)] [24 inches (610 mm)] [36 inches (910 mm)] <Insert dimension>**. **[Adaptable horizontal dimensions as required for existing roof openings.]**
- D. **[Wind] [and] [Seismic]** Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in **[Section 230548 "Vibration and Seismic Controls for HVAC"]** **[Section 230548.13 "Vibration Controls for HVAC"]** for wind-load requirements.

2.15 INTAKE AND RELIEF AIR OPENINGS

- A. Provide hood, including moisture eliminator, over all unit intake and relief openings. Match material and finish of casing exterior.

2.16 MATERIALS

- A. Steel:
1. ASTM A36/A36M for carbon structural steel.
 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
1. Manufacturer's standard grade for casing.
 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209 (ASTM B209M).
- E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

- F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
 - c. ASTM B3359 for cross-hatch adhesion of 5B.
 - 2. Application: Spray.
 - 3. Thickness: 1 mil (0.025 mm).
 - 4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.17 SOURCE QUALITY CONTROL

- A. AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.
- B. AHRI 1060 Certification: Test, rate, and label air-handling units that include air-to-air energy recovery devices in accordance with AHRI 1060.
- C. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.
- D. Fan Aerodynamic Performance Rating: Test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.
- E. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.
- F. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.
- G. Water Coils: Factory tested to 300 psig (2070 kPa) according to AHRI 410 and ASHRAE 33.
- H. Steam Coils: Factory tested to 300 and 200 psig (2070 and 1380 kPa) underwater according to AHRI 410 and ASHRAE 33.
- I. Refrigerant Coils: Factory tested to minimum 450-psig (3105-kPa) internal pressure and to minimum 300-psig (2070-kPa) internal pressure while underwater, according to AHRI 410 and ASHRAE 33.
- J. Witnessed Casing Leakage Tests:
 - 1. Pay for all expenses, for one representative designated by Owner, to travel to the factory to witness cabinet air-leakage testing on the specific assembled unit(s) prior to release for delivery to Project site.
 - 2. If the unit(s) does not meet specified leakage requirements, perform factory modifications and retest. Do not release unit for shipment until tested leakage is measured to be within specified leakage and leakage testing report has been accepted by Owner's designated representative.

PART 3 - EXECUTION – NOT USED

END OF SECTION 237343.16

SECTION 237416.11 - PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following:
 - 1. Adhesives: VOC content and emissions evaluation.
 - 2. Sealants: VOC content and emissions evaluation.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
- D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE 15 Compliance: For refrigeration system safety.
- F. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- G. UL Compliance: Comply with UL 1995.
- H. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
- I. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."
- J. All units shall be provided with full economizer mode as applicable.

2.2 PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AAON.
 - 2. Addison.
 - 3. Allied Commercial.
 - 4. Carrier Global Corporation.
 - 5. Daikin Applied.
 - 6. Engineered Air.
 - 7. Lennox Industries, Inc.; Lennox International.
 - 8. Rheem Manufacturing Company; Heating and Cooling Products.
 - 9. Trane.
 - 10. Valent.
 - 11. YORK; brand of Johnson Controls International plc, Building Solutions North America.
 - 12. **<Insert manufacturer's name>.**

2.3 UNIT CASINGS

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Double-Wall Construction:
 - 1. Outside Casing Wall: **[Galvanized steel]** **<Insert material>**, minimum **[18 gauge (1.3 mm)]** **<Insert value>** thick with **[manufacturer's standard finish]** **[corrosion-resistant coating]** **<Insert special coating>**, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 2. Inside Casing Wall: G90 (Z275)-coated galvanized steel, **[0.034 inch (0.86 mm)]** **[0.028 inch (0.7 mm)]** **<Insert dimension>** thick, **[perforated 40 percent free area]**.
 - 3. Floor Plate: **[G90 (Z275) galvanized steel]** **<Insert material>**, **[treadplate]**, minimum **[18 gauge (1.3 mm)]** **<Insert value>** thick.
 - 4. Casing Insulation:
 - a. Materials: Injected polyurethane foam insulation.
 - b. Casing Panel R-Value: Minimum **<Insert value>**.
 - c. Insulation Thickness: **[1 inch (25 mm)]** **[2 inches (50 mm)]**.
 - d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.
- C. Airstream Surfaces: Surfaces in contact with airstream to comply with requirements in ASHRAE 62.1.
- D. Static-Pressure Classifications:
 - 1. For Unit Sections Upstream of Fans: Minus **[2-inch wg (500 Pa)]** **[3-inch wg (750 Pa)]** **<Insert value>**.
 - 2. For Unit Sections Downstream and Including Fans: **[2-inch wg (500 Pa)]** **[3-inch wg (750 Pa)]** **[4-inch wg (1000 Pa)]** **<Insert value>**.
- E. Panels and Doors:
 - 1. Panels:
 - a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
 - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement to allow panels to be opened against air-pressure differential.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - 2. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - 3. Locations and Applications:
 - a. Fan Section: **[Inspection and access panels]** **[Doors]** **[Doors and inspection and access panels]**.
 - b. Access Section: Doors.

- c. Coil Section: Inspection and access panels.
 - d. Damper Section: **[Inspection and access panels] [Doors]**.
 - e. Filter Section: **[Inspection and access panels] [Doors]** large enough to allow periodic removal and installation of filters.
 - f. Mixing Section: Doors.
- F. Condensate Drain Pans:
- 1. Location: Each type of **[cooling coil] [rotary heat exchanger]**.
 - 2. Construction:
 - a. Single-wall, **[galvanized-steel or noncorrosive polymer] [stainless steel]** sheet.
 - 3. Drain Connection:
 - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on **[one end] [both ends]** of pan.
 - b. Minimum Connection Size: **[NPS 1 (DN 25)] [NPS 2 (DN 50)] <Insert pipe size>**.
 - 4. Slope: Minimum **[0.125-in./ft. (10-mm/mm)] <Insert value>** slope[, to comply with **ASHRAE 62.1,**] in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - 5. Length: Extend drain pan downstream from leaving face **[for distance to comply with ASHRAE 62.1] <Insert distance>**.
 - 6. Width: Entire width of water producing device.
 - 7. Depth: A minimum of **[2 inches (50 mm)] <Insert dimension>** deep.
 - 8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
 - 9. Units with stacked coils must have an intermediate drain pan to collect condensate from top coil.

2.4 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.
 - 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 - 2. Shaft Bearings:
 - a. Heavy-duty, self-aligning, pillow-block type with an **[L-50] <Insert bearing life rating>** rated life of minimum **[100,000] <Insert number>** hours according to ABMA 9.
 - 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.

5. Mounting: For internal vibration isolation[**and seismic control**]. Factory-mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of **[1 inch (25 mm)]** **<Insert dimension>**.
6. Shaft Lubrication Lines: Extended to a location outside the casing.
7. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches (89 mm) wide, attached to two strips of minimum 2-3/4-inch- (70-mm-)wide by 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives to comply with UL 181, Class 1.
- C. Drives, Direct: Factory-mounted, direct drive.
- D. Drives, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with **[1.5]** **[1.25]** service factor based on fan motor.
 1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
 2. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
 3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; **[0.146-inch- (2.7-mm-)]** **<Insert dimension>** thick, **[3/4-inch (20-mm)]** **<Insert dimension>** diamond-mesh wire screen, welded to steel angle frame; prime coated.
- E. Condenser-Coil Fan: **[Variable-speed]** propeller, mounted on shaft of permanently lubricated **[multispeed]** **[ECM]** motors.
- F. Relief-Air Fan: **[Propeller]** **[Forward curved]** **[Backward inclined]**, shaft mounted on permanently lubricated motor.
- G. Motors:
 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 3. Enclosure Type: **[Open, dripproof]** **[Totally enclosed, fan cooled]** **<Insert type>**.
 4. Enclosure Materials: **[Cast iron]** **<Insert material>**.
 5. Motor Bearings: **<Insert requirements>**.
 6. Unusual Service Conditions:
 - a. Ambient Temperature: **<Insert deg C>**.
 - b. Altitude: **<Insert feet (m)>** above sea level.
 - c. High humidity.
 - d. **<Insert conditions>**.
 7. Efficiency: Premium efficient as defined in NEMA MG 1.
 8. NEMA Design: **<Insert designation>**.
 9. Motor Pulleys: Adjustable pitch for use with **[5]** **<Insert number>**-hp motors and smaller; fixed pitch for use with motors larger than **[5]** **<Insert number>** hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
 10. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.5 ROTARY HEAT EXCHANGER

- A. Heat exchanger integral with unit.

B. Casing:

1. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory-painted finish.
2. Integral purge section limiting carryover of exhaust air to between **[0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa)]** **<Insert values>** differential pressure.
3. Casing seals on periphery of rotor and on duct divider and purge section.
4. Support vertical rotor on grease-lubricated ball bearings having extended grease fittings[**or permanently lubricated bearings**]. Support horizontal rotors on tapered roller bearing.

C. Rotor - Aluminum or Polymer: Segmented wheel, strengthened with radial spokes[, **with nontoxic, noncorrosive, silica-gel desiccant coating**].

D. Rotor - Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, 3-angstrom molecular-sieve desiccant coating.

E. Drive: Fractional horsepower motor and gear reducer[, **with speed changed by variable-frequency controller**]. Permanently lubricated wheel bearings with an **[L-10]** **<Insert bearing life>** **[400,000 hours]** **<Insert hours>**.

F. Controls:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2. Variable-frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.
3. Variable-frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
4. Variable-frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain[**exhaust temperature above freezing and**] air differential temperature above set point. Rotor speed is to increase to maximum when exhaust-air temperature is less than outdoor-air temperature.
5. Control energy recovery to permit air economizer operation.
 - a. Bypass dampers to assist energy recovery control.
6. Pilot-Light Indicator: Display rotor rotation and speed.
7. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
8. Defrost cycle.

2.6 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow for removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils to not act as structural component of unit.

B. Supply-Air Refrigerant Coil:

1. Tubes: **[Copper]** **<Insert material>**.
2. Fins:
 - a. Material: **[Aluminum]** **[Copper]** **<Insert material>**.
 - b. Fin Spacing: Maximum **[12]** **[10]** **[8]** **<Insert spacing>** fins per inch (mm).

3. Fin and Tube Joints: Mechanical bond.
 4. Headers: [**Seamless-copper headers with brazed connections**] <Insert material and connections>.
 5. Frames: [**Galvanized steel**] [**Stainless steel**] <Insert material frame>.
 6. Coatings: [**None**] [**Corrosion-resistant coating**].
 7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig (2070 kPa).
- C. Outdoor-Air Refrigerant Coil:
1. Tubes: [**Copper**] <Insert material>.
 2. Fins:
 - a. Material: [**Aluminum**] [**Copper**] <Insert material>.
 - b. Fin Spacing: Maximum [**12**] [**10**] [**8**] <Insert spacing> fins per inch (mm).
 3. Fin and Tube Joints: Mechanical bond.
 4. Headers: [**Seamless-copper headers with brazed connections**] <Insert material and connections>.
 5. Frames: [**Galvanized steel**] [**Stainless steel**] <Insert material frame>.
 6. Coatings: [**None**] [**Corrosion-resistant coating**].
 7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig (2070 kPa).
- D. Hot-Gas Reheat Refrigerant Coil:
1. Tubes: [**Copper**] <Insert material>.
 2. Fins:
 - a. Material: [**Aluminum**] [**Copper**] <Insert material>.
 - b. Fin Spacing: Maximum [**12**] [**10**] [**8**] <Insert spacing> fins per inch (mm).
 3. Fin and Tube Joints: Mechanical bond.
 4. Headers: [**Seamless-copper headers with brazed connections**] <Insert material and connections>.
 5. Frames: [**Galvanized steel**] [**Stainless steel**] <Insert material frame>.
 6. Coatings: [**None**] [**Corrosion-resistant coating**].
 7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig (2070 kPa).
 8. Suction-discharge bypass valve.
- E. Electric-Resistance Heating Coils: Comply with UL 1995.
1. Casing Assembly: [**Slip-in**] [**Flanged**] type with galvanized-steel frame.
 2. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
 3. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
 4. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
 5. Control Panel: [**Unit**] [**Remote**] mounted with disconnecting means and overcurrent protection.
 - a. [**Magnetic**] [**Mercury**] contactor.
 - b. Solid-state, stepless pulse controller.
 - c. Toggle switches, one per step.

- d. Step controller.
- e. Time-delay relay.
- f. Pilot lights, one per step.
- g. Airflow proving switch.

2.7 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor: Hermetic, [**variable-speed**] scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief[, **and crankcase heater**].
- B. Refrigeration Specialties:
 - 1. Refrigerant: [**R-410A**] <Insert refrigerant type>.
 - 2. Expansion valve with replaceable thermostatic element.
 - 3. Refrigerant filter/dryer.
 - 4. Manual-reset high-pressure safety switch.
 - 5. Automatic-reset low-pressure safety switch.
 - 6. Minimum off-time relay.
 - 7. Automatic-reset compressor motor thermal overload.
 - 8. Brass service valves installed in compressor suction and liquid lines.
 - 9. Low-ambient kit high-pressure sensor.
 - 10. Hot-gas reheat solenoid valve [**single stage**] [**modulating**] with a replaceable magnetic coil.
 - 11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
 - 12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.8 AIR FILTRATION

- A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
- B. Panel Filters:
 - 1. Description: [**Flat, non-pleated**] [**Pleated**] factory-fabricated, self-supported, disposable air filters with holding frames.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
 - 4. Filter-Media Frame: [**Beverage board**] <Insert material> with perforated metal retainer, or metal grid, on outlet side.
- C. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
- D. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.9 GAS FURNACES

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.
- B. CSA Approval: Designed and certified by and bearing label of CSA.
- C. Burners: Stainless steel.
 - 1. Rated Minimum Turndown Ratio: [**30 to 1**] <Insert ratio>.

2. Fuel: **[Natural] [Propane]** gas.
 3. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
 4. Gas Control Valve: **[Single stage] [Two stage] [Modulating]**.
 5. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
 6. High Altitude: For Project elevations more than 2000 feet (610 m) above sea level, provide high-altitude **[model] [kit]**.
- D. Heat-Exchanger and Drain Pan: Stainless steel.
- E. Venting, Gravity: Gravity vented **[with vertical extension]**.
- F. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve **[with vertical extension]**.
- G. Safety Controls:
1. Gas Manifold: Safety switches and controls complying with ANSI standards **[and] [FM Global] <Insert insurer>**.
- 2.10 DAMPERS
- A. Comply with requirements in Section 230923.12 "Control Dampers."
- B. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, **[galvanized-steel] <Insert material>** dampers with compressible jamb seals and extruded-vinyl blade edge seals in **[opposed] [parallel]**-blade arrangement with **[zinc-plated] steel** operating rods rotating in **[sintered bronze or nylon] <Insert material>** bearings mounted in a single **[galvanized-steel] <Insert material>** frame, and with operating rods connected with a common linkage. Leakage rate must not exceed 4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa) rated in accordance with AMCA 500D.
- C. Barometric relief dampers.
- D. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
- E. Electronic Damper Operators:
1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 2. Electronic damper position indicator to have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
 3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
 5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

6. Size dampers for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
 - e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): **[24 V dc] [120 V ac] [230 V ac]**.
11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
12. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
13. Temperature Rating: **[Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)] [40 to 104 deg F (5 to 40 deg C)]**.
14. Run Time: **[12 seconds open, 5 seconds closed] [30 seconds] [60 seconds] [120 seconds]**.

2.11 ELECTRICAL POWER CONNECTIONS

- A. RTU to have a single connection of power to unit with **[unit-mounted disconnect switch accessible from outside unit and]** control-circuit transformer with built-in overcurrent protection.

2.12 CONTROLS

- A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- B. Basic Unit Controls:
 1. Control-voltage transformer.
 2. Wall-mounted thermostat or sensor with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. **[Manual] [Automatic]** changeover.
 - e. Adjustable deadband.
 - f. **[Concealed] [Exposed]** set point.
 - g. **[Concealed] [Exposed]** indication.
 - h. **[Degree F] [Degree C]** indication.
 - i. Unoccupied-period-override push button.
 - j. Data entry and access port to input temperature **[and humidity]** set points, occupied and unoccupied periods, and output room temperature **[and humidity]**, supply-air temperature, operating mode, and status.

3. Wall-mounted humidistat or sensor with the following features:
 - a. **[Concealed] [Exposed]** set point.
 - b. **[Concealed] [Exposed]** indication.
 4. Annunciator Panel for Each Unit:
 - a. Configuration: **[Remote wall-] [Unit-]**mounted.
 - b. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
 - c. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
 - d. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.
- C. Controller:
1. Type: **[Electronic] [DDC]**.
 2. Controller to have volatile-memory backup.
 3. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire-alarm control panel.
 - b. Firestats: Stop fan and close outdoor-air damper if air greater than **[130 deg F (54 deg C)] <Insert temperature>** enters unit. Provide additional contacts for alarm interface to fire-alarm control panel.
 - c. Fire-Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in **[Section 284621.11 "Addressable Fire-Alarm Systems. "] [Section 284621.13 "Conventional Fire-Alarm Systems. "]**
 - d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply-air temperature is less than **[40 deg F (4 deg C)] <Insert temperature>**.
 - e. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
 4. Scheduled Operation: Occupied and unoccupied periods on **[seven] [365]**-day clock with a minimum of **[two] [four]** programmable periods per day.
 5. Unoccupied Period:
 - a. Heating Setback: **[10 deg F (5.6 deg C)] <Insert temperature>**.
 - b. Cooling Setback: System off.
 - c. Override Operation: **[Two] <Insert number>** hours.
 6. Supply Fan Operation:
 - a. Occupied Periods: Run fan continuously.
 - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
 7. Refrigerant Circuit Operation:
 - a. Occupied Periods: Cycle or stage compressors[, and operate hot-gas bypass] to match compressor output to cooling load to maintain **[room] [discharge] temperature [and humidity]**. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
 - b. Unoccupied Periods: **[Compressors off] [Cycle compressors and condenser fans for heating to maintain setback temperature]**.
 - c. Switch reversing valve for heating or cooling mode on air-to-air heat pump.

8. Hot-Gas Reheat-Coil Operation:
 - a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles the compressor.
 - b. Unoccupied Periods: Reheat not required.
 9. Gas Furnace Operation:
 - a. Occupied Periods: **[Cycle] [Stage] [Modulate]** burner to maintain **[room] [discharge]** temperature.
 - b. Unoccupied Periods: Cycle burner to maintain setback temperature.
 10. Electric-Heating-Coil Operation:
 - a. Occupied Periods: **[Cycle] [Stage] [Modulate]** coil to maintain **[room] [discharge]** temperature.
 - b. Unoccupied Periods: Energize coil to maintain setback temperature.
 - c. Operate supplemental electric heating coil with compressor for heating with outdoor temperature below **[25 deg F (minus 4 deg C)] <Insert temperature>**.
 11. Fixed Minimum Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open to **[25] <Insert number>** percent.
 - b. Unoccupied Periods: Close the outdoor-air damper.
 12. Economizer Outdoor-Air Damper Operation:
 - a. Morning **[warm-up] [cool-down] [building outdoor-air flush]** cycles.
 - b. Occupied Periods: Open to **[10] [25] <Insert number>** percent fixed minimum intake, and maximum 100 percent of the fan capacity. Controller is to permit air-side economizer operation when outdoor air is less than **[60 deg F (15 deg C)] <Insert temperature>**. Use **[outdoor-air temperature] [mixed-air and outdoor-air temperature] [outdoor-air enthalpy] [mixed-air temperature and select between outdoor-air and return-air enthalpy]** to adjust mixing dampers. **[Start relief-air fan with end switch on outdoor-air damper.]** During economizer cycle operation, lock out cooling.
 - c. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
 - d. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor to adjust for temperature, and output to range from **[2- to 10-V dc] [4 to 20 mA] <Insert value>**.
 13. Carbon Dioxide Sensor Operation:
 - a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum **[10] <Insert number>** percent to maintain maximum **[1000-ppm] <Insert value>** concentration.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
 14. Terminal-Unit Relays:
 - a. Provide heating- and cooling-mode changeover relays compatible with terminal control system required in Section 233600 "Air Terminal Units" and Section 230923 "Direct Digital Control (DDC) System for HVAC."
- D. Interface Requirements for HVAC Instrumentation and Control System:
1. Interface relay for scheduled operation.
 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.

3. Provide **[BACnet]** **[or]** **[LonWorks]** compatible interface for central HVAC control workstation for the following:
 - a. Adjusting set points.
 - b. Monitoring supply fan start, stop, and operation.
 - c. Inquiring data to include **[outdoor-air damper position,]** supply- and room-air temperature **[and humidity]**.
 - d. Monitoring occupied and unoccupied operations.
 - e. Monitoring constant and variable motor loads.
 - f. Monitoring variable-frequency drive operation.
 - g. Monitoring cooling load.
 - h. Monitoring economizer cycles.
 - i. Monitoring air-distribution static pressure and ventilation air volume.

2.13 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C1071, Type I or II.
 - b. Thickness: **[1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension>**.
 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location to have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
- C. Curb Dimensions: Height of **[14 inches (355 mm)] [24 inches (610 mm)] [36 inches (910 mm)] <Insert dimension>**. **[Adaptable horizontal dimensions as required for existing roof openings.]**

2.14 ACCESSORIES

- A. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature in gas burner compartment.
- B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. **[Outlet is to be energized even if the unit main disconnect is open.]**
- C. Low-ambient kit using **[staged]** **[damper on]** **[variable-speed]** condenser fans for operation down to **[35 deg F (1.7 deg C)] <Insert temperature>**.
- D. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- E. Remote potentiometer to adjust minimum economizer damper position.

- F. Return-air bypass damper.
- G. Factory- or field-installed, demand-controlled ventilation.
- H. Safeties:
 - 1. Smoke detector.
 - 2. Condensate overflow switch.
 - 3. Phase-loss [**reversal**] protection.
 - 4. High [**and low**] pressure control.
 - 5. [**Gas furnace**] [**Electric coil**] airflow-proving switch.
- I. Coil guards of painted, galvanized-steel wire.
- J. Hail guards of galvanized steel, painted to match casing.
- K. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.
- L. Door switches to disable heating or reset set point when open.
- M. Outdoor-air intake weather hood[**with moisture eliminator**].
- N. Oil separator.
- O. Service Lights and Switch: Factory installed in [**fan section**] [**fan and coil sections**] [**each accessible section**] <Insert locations> with weatherproof cover. Factory wire lights to a single-point field connection.

2.15 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209 (ASTM B209M).
- E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
- F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [**3000**] <Insert time>-hour salt-spray test according to ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
 - c. ASTM B3359 for cross-hatch adhesion of 5B.
 - 2. Application: [**Immersion**] [**Spray**].
 - 3. Thickness: [**1 mil (0.025 mm)**] <Insert value>.
 - 4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.16 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested according to AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

PART 3 - EXECUTION – NOT USED

END OF SECTION 237416.11

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following:
 - 1. Adhesives: VOC content and emissions evaluation.
 - 2. Sealants: VOC content and emissions evaluation.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an "NRTL" (nationally recognized testing laboratory) and marked for intended location and application.
- C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.
- D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.
- F. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- G. ASHRAE 84 Compliance: Comply with capacity ratings for **[heat-wheel] [fixed plate]** energy-recovery equipment.
- H. UL Compliance:
 - 1. Electric Coils: Comply with requirements in UL 1995.
- I. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design **[vibration isolation] [seismic restraints] [and] [wind restraints]**.
- J. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."

2.2 EVAPORATIVE COOLING OR SWAMP COOLERS

This specification will be added for 100% Outside Air Swamp Coolers directly evaporating water into the air stream for cooling. Two(2) types are permitted: Pad isolated from water flow(indirect), and Moisture Sensors on Pad(Direct) with direct spray on Pad until water is evaporated. Units are to be configured of all stainless steel construction. Refer to this section for air-side components and coordinate with cooling tower section for water side components including filtering and water treatment.

2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AAON.
 - 2. Addison.
 - 3. Desert Aire.
 - 4. Munters Corporation.

5. REZNOR, a brand of Nortek Global HVAC.
6. **<Insert manufacturer's name>.**

B. Source Limitations: Obtain dedicated outdoor-air units from single manufacturer.

2.4 UNIT CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Configuration: Horizontal unit with **[top]** **[horizontal]** **[bottom]** discharge for **[roof-mounting]** **[concrete-base]** installation.
- C. Double-Wall Configuration:
1. Outside Casing Wall: **[Galvanized steel]** **[Stainless steel]** [, **stainless steel in cooling coil section**] **<Insert material>**, minimum **[18 gauge (1.3 mm)]** **<Insert value>** thick with **[manufacturer's standard finish]** **[corrosion-resistant coating]** **<Insert special coating>**, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 2. Inside Casing Wall:
 - a. Inside Casing, Burner Section: **[Galvanized steel]** **<Insert material>**, solid, minimum **[14-gauge- (0.759-mm-)]** **<Insert value>** thick steel.
 - b. Inside Casing, All Other Sections: **[Galvanized steel]** **<Insert material>**, **[solid]** **[perforated]**.
 - c. Antimicrobial Coating: Applied during the manufacturing process. Coating is to be **[EPA approved]** **[NSF approved]** **[FDA listed]**.
 3. Floor Plate: Reinforced metal surface; reinforced to limit deflection when walked on by service personnel. Insulation is provided below metal walking surface.
 4. Roof: Standing seam or membrane; sloped to drain water.
 5. Casing Insulation:
 - a. Materials: Polyurethane foam insulation.
 - b. Casing Panel R-Value: Minimum **[R-6.5]** **[R-11]** **[R-13]** **<Insert value>**.
 - c. Insulation Thickness: **[1 inch (25 mm)]** **[2 inches (50 mm)]** **<Insert dimension>**.
 - d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
- D. Static-Pressure Classifications:
1. For Unit Sections Upstream of Fans: Minus **[2 inches wg (500 Pa)]** **[3 inches wg (750 Pa)]** **<Insert value>**.
 2. For Unit Sections Downstream and Including Fans: **[2 inches wg (500 Pa)]** **[3 inches wg (750 Pa)]** **[4 inches wg (1000 Pa)]** **<Insert value>**.
- E. Panels and Doors:
1. Panels:
 - a. Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Fasteners: Two or more camlock-type fasteners for panel lift-out operation. Arrangement shall allow panels to be opened against airflow
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components

2. Doors:
 - a. Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.
3. Locations and Applications:
 - a. Fan Section: **[Panels] [Doors]**.
 - b. Access Section: Doors.
 - c. Gas-Fired Burner Section: **[Panels] [Doors]**.
 - d. Damper Section: **[Panels] [Doors]**.
 - e. Filter Section: **[Panels] [Doors]** large enough to allow periodic removal and installation of filters.
 - f. Relief Section: Doors.

F. Condensate Drain Pans:

1. Location: Each refrigerant coil **[and rotary heat exchanger]**.
2. Construction:
 - a. Single-wall, **[galvanized-steel or noncorrosive polymer] [stainless steel]** sheet.
3. Size: Large enough to collect condensate from cooling coils, including coil piping connections, coil headers, and return bends.
4. Drain Connection:
 - a. Located on **[one end] [both ends]** of pan, at lowest point of pan.
 - b. Terminated with threaded nipple.
 - c. Minimum Connection Size: **[NPS 1 (DN 25)] [NPS 2 (DN 50)] <Insert pipe size>**.
5. Slope: Minimum **[0.125-inch/ft. (10-mm/m)] <Insert value>** slope[, **to comply with ASHRAE 62.1,**] in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
6. Length: Extend drain pan downstream from leaving face **[for distance to comply with ASHRAE 62.1] <Insert distance>**.
7. Width: Entire width of water-producing device.
8. Depth: A minimum of **[2 inches (50 mm)] <Insert dimension>** deep.
9. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
10. Provide units having stacked coils with intermediate drain pan to collect condensate from top coil.

2.5 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

- B. Supply-Air Fans and Relief-Air Fans: Centrifugal; galvanized or painted steel; mounted on solid-steel shaft.
1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 2. Shaft Bearings:
 - a. Heavy-duty, self-aligning, pillow-block type with an **[L-50] <Insert bearing life rating>** rated life of minimum **[100,000] <Insert number>** hours in accordance with ABMA 9.
 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 4. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
 5. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; **[steel] [aluminum]** hub riveted to backplate and fastened to shaft with setscrews.
 6. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; **[steel] [aluminum]** hub swaged to backplate and fastened to shaft with setscrews.
 7. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
 8. Mounting: For internal vibration isolation[**and seismic control**]. Factory mount fans with manufacturer's standard[**restrained**] vibration isolation mounting devices having a minimum static deflection of **[1 inch (25 mm)] [2 inches (50 mm)] <Insert dimension>**.
 9. Shaft Lubrication Lines: Extended to a location outside the casing.
 10. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches (89 mm) **<Insert dimension>** wide, attached to two strips of minimum 2-3/4-inch- (70-mm-) wide **<Insert width>** by 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
- C. Drive, Direct: Factory-mounted direct drive.
- D. Drive, Belt: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with **[1.5] [1.25]** service factor based on fan motor.
1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
 2. Belts: Oil resistant, nonsparking and nonstatic; in matched sets for multiple-belt drives.
 3. Belt Guards: Comply with requirements specified by OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards"; **[0.146 inch (2.7 mm)] <Insert dimension>** thick, **[3/4-inch (20-mm)] <Insert dimension>** diamond-mesh wire screen, welded to steel angle frame; prime coated.
- E. Condenser-Coil Fan: **[Variable-speed]** propeller, mounted on shaft of permanently lubricated **[multispeed] [electronically commutated]** motors.

F. Motors:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Enclosure Type: **[Open, dripproof] [Totally enclosed, fan cooled] <Insert type>**.
4. Enclosure Materials: **[Cast iron] <Insert material>**.
5. Motor Bearings: **<Insert requirements>**.
6. Unusual Service Conditions:
 - a. Ambient Temperature: **<Insert deg C (deg C)>**.
 - b. Altitude: **<Insert feet (m)>** above sea level.
 - c. High humidity.
 - d. **<Insert conditions>**.
7. Efficiency: Premium efficient as defined in NEMA MG 1.
8. NEMA Design: **<Insert designation>**.
9. Motor Pulleys: Adjustable pitch for use with **[5] <Insert number>** hp motors and smaller; fixed pitch for use with motors larger than **[5] <Insert number>** hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
10. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
11. **<Insert unique motor characteristics>**.
12. Mount unit-mounted disconnect switches on **[exterior] [interior]** of unit.

G. Comply with Section 262923 "Variable-Frequency Motor Controllers."

H. Variable-Frequency Motor Controller: Serving **[each fan individually] [all fans combined]** in fan array.

1. Manufactured Units: Pulse-width modulated; **[constant torque] [and] [variable torque] <Insert application>** for **[Design A and Design B] [inverter-duty]** motors.
2. Output Rating: Three phase; 10 to **[60 Hz, with voltage proportional to frequency throughout voltage range] [66 Hz, with torque constant as speed changes]**; maximum voltage equals input voltage.
3. Unit Operating Requirements:
 - a. Internal Adjustability:
 - 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] <Insert range>** seconds.
 - 4) Deceleration: **[0.1 to 999.9] <Insert range>** seconds.
 - 5) Current Limit: 30 to minimum of 150 percent of maximum rating.
 - b. Self-Protection and Reliability Features:
 - 1) Surge suppression.
 - 2) Loss of input signal protection.
 - 3) Under- and overvoltage trips.
 - 4) Variable-frequency motor controller and motor-overload/overtemperature protection.
 - 5) Critical frequency rejection.
 - 6) Loss-of-phase protection.
 - 7) Reverse-phase protection.
 - 8) Motor-overtemperature fault.

- c. Bidirectional autospeed search.
 - d. Torque boost.
 - e. Motor temperature compensation at slow speeds.
 - 1) Panel-mounted operator station.
 - 2) Historical logging information and displays.
 - 3) Digital indicating devices.
 - f. Control Signal Interface: Electric.
 - g. Proportional Integral Directive (PID) control interface.
 - h. DDC system for HVAC Protocols for Network Communications: **[ASHRAE 135]**
<Insert protocol type>.
- 4. Line Conditioning:
 - a. Input line conditioning.
 - b. Output filtering.
 - c. EMI/RFI filtering.
- 5. Bypass Systems:
 - a. Bypass Mode: **[Manual operation only] [Field-selectable automatic or manual]**.
 - b. Bypass Controller, Two-Contactor Style: With bypass and output isolating contactors[**and isolating switch**].
 - c. Bypass Controller, Three-Contactor Style: With bypass and input and output isolating contactors[**and isolating switch**].
 - d. Bypass Contactor Configuration: **[Full-voltage (across the line)] [Reduced-voltage (autotransformer)] <Insert type>** type.

2.6 COILS

A. General Requirements for Coils:

- 1. Comply with AHRI 410.
- 2. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
- 3. Coils are not to act as structural component of unit.

B. Supply-Air Refrigerant Coils:

- 1. Tubes: **[Copper] <Insert material>**.
- 2. Fins:
 - a. Material: **[Aluminum] [Copper] <Insert material>**.
 - b. Fin Spacing: Maximum **[12] [10] [8] <Insert spacing>** fins per inch (mm).
- 3. Fin and Tube Joints: Mechanical bond.
- 4. Headers: **[Seamless-copper headers with brazed connections] <Insert material and connections>**.
- 5. Frames: **[Galvanized steel] <Insert material frame>**.
- 6. Coatings: **[None] [Corrosion-resistant coating]**.
- 7. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig (2070 kPa).

C. Hot-Gas Reheat Refrigerant Coils:

- 1. Tubes: **[Copper] <Insert material>**.
- 2. Fins:
 - a. Material: **[Aluminum] [Copper] <Insert material>**.

- b. Fin Spacing: Maximum **[12] [10] [8] <Insert spacing>** fins per inch (mm).
- 3. Fin and Tube Joints: Mechanical bond.
- 4. Headers: **[Seamless-copper headers with brazed connections] <Insert material and connections>**.
- 5. Frames: **[Galvanized steel] [Stainless steel] <Insert material frame>**.
- 6. Coatings: **[None] [Corrosion-resistant coating]**.
- 7. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig (2070 kPa).
- 8. Coating: **[None] [Corrosion-resistant coating]**.
- 9. Suction-discharge bypass valve.
- D. Electric-Resistance Heating Coils: Comply with UL 1995.
 - 1. Casing Assembly: **[Slip-in] [Flanged]** type with galvanized-steel frame.
 - 2. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
 - 3. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
 - 4. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
 - 5. Control Panel: **[Unit] [Remote]** mounted with disconnecting means and overcurrent protection.
 - a. Magnetic contactor.
 - b. Solid-state, stepless pulse controller.
 - c. Toggle switches, one per step.
 - d. **[Step] [SCR]** controller.
 - e. Time-delay relay.
 - f. Pilot lights, one per step.
 - g. Airflow proving switch.
- E. Heating-Water Coils: **[Continuous circuit] [Self-draining] [Cleaning]**.
 - 1. Piping Connections: **[Threaded] [Flanged], [same end] [opposite ends]** of coil.
 - 2. Tube Material: **[Copper] <Insert material>**.
 - 3. Fin Type: Plate.
 - 4. Fin Material: **[Aluminum] [Copper] <Insert material>**.
 - 5. Fin Thickness: **<Insert inches (mm)>**.
 - 6. Fin and Tube Joint: **[Mechanical bond] [Silver brazed]**.
 - 7. Headers:
 - a. Cast iron with **[cleaning plugs and]** drain and air vent tappings **[extended to exterior of unit]**.
 - b. Seamless copper tube with brazed joints, prime coated.
 - c. Fabricated steel, with brazed joints, prime coated.
 - d. Provide insulated cover to conceal exposed outside casings of headers.
 - e. Frames: Channel frame, minimum 0.052-inch (1.3-mm) thick galvanized steel.
 - f. Coil Working-Pressure Ratings: **[200 psig (1380 kPa), 325 deg F (163 deg C)] <Insert value and temperature>**.
 - 8. Coating: **[None] [Corrosion-resistant coating]**.

F. Steam Heating Coils:

1. Steam Coils: **[Distributed] [Single tube]**.
 - a. Steam Outer-Tube Diameter: **<Insert inches (mm)>**.
 - b. Piping Connections: **[Threaded] [Flanged]**, **[same end] [opposite ends]** of coil.
 - c. Tube Material: **[Copper] <Insert material>**.
 - d. Fin Type: Plate.
 - e. Fin Material: **[Aluminum] [Copper] <Insert material>**.
 - f. Fin Thickness: **<Insert inches (mm)>**.
 - g. Fin and Tube Joint: **[Mechanical bond] [Silver brazed]**.
 - h. Headers:
 - 1) Cast iron with **[cleaning plugs and]** drain and air vent tappings **[extended to exterior of unit]**.
 - 2) Seamless copper tube with brazed joints, prime coated.
 - 3) Fabricated steel, with brazed joints, prime coated.
 - 4) Provide insulated cover to conceal exposed outside casings of headers.
 - i. Frames: Channel frame, minimum 0.052-inch (1.3-mm) thick galvanized steel.
 - j. Coil Working-Pressure Ratings: **[200 psig (1380 kPa), 325 deg F (163 deg C)] <Insert value and temperature>**.
 - k. Coating: **[None] [Corrosion-resistant coating]**.

G. Condenser Refrigerant coils:

1. Tube Material: **[Copper] <Insert material>**.
2. Fin Material: **[Aluminum] [Copper]**.
3. Fin and Tube Joint: Mechanical bond.
4. Coating: **[None] [Corrosion-resistant]**.

2.7 REFRIGERATION CIRCUIT COMPONENTS

- A. Compressors: Hermetic, **[variable-speed]** scroll compressors, mounted on integral vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, **and crankcase heater**.
- B. Refrigerant: **[R-410A] <Insert other available type>**.
- C. Refrigeration Specialties:
 1. Expansion valve with replaceable thermostatic element.
 2. Refrigerant filter/dryer.
 3. Manual-reset high-pressure safety switch.
 4. Automatic-reset low-pressure safety switch.
 5. Minimum off-time relay.
 6. Automatic-reset compressor motor thermal overload.
 7. Thermostat for coil freeze-up protection during low-ambient-temperature operation or loss of air.
 8. Brass service valves installed in discharge and liquid lines.
 9. Low-ambient kit high-pressure sensor.
 10. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
 11. **[Single stage] [Modulating]** hot-gas reheat solenoid valve with a replaceable magnetic coil.
 12. Heat-pipe heat exchanger, wrapped around the evaporator coil to pre-cool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.

13. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification for single-speed compressor.

2.8 AIR FILTRATION

- A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
- B. Panel Filters:
 1. Description: **[Flat, nonpleated] [Pleated]** factory-fabricated, self-supported disposable air filters with holding frames.
 2. Filter Unit Class: UL 900.
 3. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
 4. Filter-Media Frame: **[High wet-strength beverage board] <Insert material>** with perforated metal retainer, or metal grid, on outlet side.
- C. Adhesive: As recommended by air-filter manufacturer and with a VOC content of **[80] <Insert value>** g/L or less.
- D. Mounting Frames:
 1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
 2. Cartridge filters arranged for flat orientation, removable from access plenum.
 3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks **[with space for prefilter]**.

2.9 ROTARY HEAT EXCHANGER

- A. Casing:
 1. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory-painted finish.
 2. Integral purge section limiting carryover of exhaust air to between **[0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa)] <Insert values>** differential pressure.
 3. Casing seals on periphery of rotor and on duct divider and purge section.
 4. Support vertical rotor on grease-lubricated ball bearings having extended grease fittings **[or permanently lubricated bearings]**. Support horizontal rotors on tapered roller bearings.
- B. Rotor - Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
- C. Drive: Fractional horsepower motor and gear reducer **[, with speed changed by variable-frequency controller]**. Provide permanently lubricated wheel bearings.
- D. Controls:
 1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 2. Variable-frequency controller, factory mounted and wired, permitting input of 4-20 mA or 1-10 V control signal.
 3. Control energy recovery to permit air economizer operation.
 - a. Bypass dampers to assist energy recovery control.
 4. Pilot-Light Indicator: Display rotor rotation and speed.
 5. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

6. Integral purge section limiting carryover of exhaust air to between **[0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.05 percent at 400-Pa and 0.20 percent at 1000-Pa)]** **<Insert value>** differential pressure.
7. Defrost cycle.
8. **<Insert additional control features>**.

2.10 INDIRECT-FIRED GAS FURNACE HEATING

- A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.
- B. CSA Approval: Designed and certified by and bearing label of CSA.
- C. Burners:
 1. Heat-Exchanger Material: **[Aluminized steel with stainless steel inserts] [Stainless steel]**.
 2. Fuel: **[Natural] [Propane]** gas.
 3. Ignition: Electronically controlled electric spark with flame sensor.
 4. Gas Control Valve: **[Single stage] [Two stage] [Electronic modulating]**.
 5. Gas Train: Single-body, regulated, redundant, 24 V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
 6. High-Altitude **[Model] [Kit]**: For Project elevations of more than 2000 feet (610 m) above sea level.
- D. Venting, Gravity: Gravity vented.
- E. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
- F. Heat-Exchanger Drain Pan: Stainless steel.
- G. Safety Controls:
 1. Gas Manifold: Safety switches and controls complying with ANSI standards **[and] [FM Global] <Insert insurer>**.
 2. Vent Flow Verification: **[Differential pressure switch to verify open vent] [Flame rollout switch]**.
 3. High Limit: Thermal switch or fuse to stop burner.
 4. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
 5. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
 6. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
 7. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.11 DAMPERS

- A. Dampers: Comply with requirements in Section 230923.12 "Control Dampers."
- B. Outdoor- and Relief-Air Dampers: Low-leakage, double-skin, airfoil-blade, **[galvanized-steel] <Insert material>** dampers with compressible jamb seals and extruded-vinyl blade edge seals in **[opposed] [parallel]**-blade arrangement with **[zinc-plated] [steel]** operating rods rotating in **[sintered bronze or nylon] <Insert material>** bearings mounted in a single **[galvanized-steel] <Insert material>** frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. (20 L/s per sq. m) at 1 inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4 inches wg (1.0 MPa).

- C. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
- D. Electronic Damper Operators:
 - 1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 2. Electronic damper position indicator shall have visual scale indicating percentage of travel and 2 to 10 V dc feedback signal.
 - 3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
 - 5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
 - 6. Size dampers for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
 - e. Dampers with 2 to 3 Inches wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
 - f. Dampers with 3 to 4 Inches wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
 - 7. Coupling: V-bolt and V-shaped, toothed cradle.
 - 8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
 - 10. Power Requirements (Two-Position Spring Return): **[24 V dc] [120 V ac] [230 V ac]**.
 - 11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
 - 12. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2 to 10 V dc position feedback signal.
 - 13. Temperature Rating: **[Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)] [40 to 104 deg F (5 to 40 deg C)]**.
 - 14. Run Time: **[12 seconds open, 5 seconds closed] [30 seconds] [60 seconds] [120 seconds]**.

2.12 ELECTRICAL POWER CONNECTIONS

- A. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a **[single-point]**field power connection to unit **[except for service lights and convenience outlets, which are to be powered separately]**.
- B. Enclosure: NEMA 250, **[Type 3R] [Type 4] [Type 4X] <Insert type>**, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key.
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface to be **[wire lugs] [NEMA KS 1, heavy-duty, nonfused disconnect switch]**.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
 - 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.
 - 2. NEMA KS 1, heavy-duty, nonfusible switch.
 - 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
 - 1. Service Lights: **<Insert number of watts> [LED] <Insert lamp type>** vaporproof luminaire with individual switched junction box located **[outside] [inside]**, adjacent to each access door and panel.
 - a. Locations: **[Each section accessed with door or panel] [Fan section] <Insert location>**.
 - 2. Convenience Outlets: One 20 A duplex GFCI receptacle per location with junction box located on outside casing wall.
 - a. Locations: **[Each section accessed with a door or panel] [Fan section] <Insert location>**.
- J. Control Relays: Auxiliary and adjustable time-delay relays.

2.13 CONTROLS

- A. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.
- B. Control Valves: Comply with requirements in Section 230923.11 "Control Valves."
- C. Control Wiring: Factory wire connection for controls' power supply.
- D. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- E. **[Remote] [Unit]-Mounted Status Panel:**
 - 1. Cooling/Off/Heating Controls: Control operational mode.

2. Damper Position: Indicate 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.
 - e. Smoke alarm.
 - f. General alarm.
 - g. **<Insert points>**.
 4. Digital Numeric Display:
 - a. Outdoor airflow.
 - b. Supply airflow.
 - c. Outdoor dry-bulb temperature.
 - d. Outdoor dew point temperature.
 - e. Space temperature.
 - f. Supply temperature.
 - g. Space relative humidity.
 - h. Space carbon dioxide level.
 - i. **<Insert points>**.
- F. Refrigeration System Controls:
1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than **[28 Btu/lb (65 kJ/kg)] <Insert value>** of dry air or outdoor-air temperature is less than 60 deg F (15 deg C) **<Insert value>**.
 2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F (15 deg C) **<Insert value>**.
 3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than **[50] <Insert value>** percent.
- G. Furnace Controls:
1. **[Factory-mounted sensor in supply outlet] [Remote sensor for field installation in supply-air duct]** with sensor adjustment located in control panel to modulate gas furnace burner to maintain space temperature.
 2. Wall-mounted, space-temperature sensor with **[temperature adjustment] [unit-mounted temperature adjustment] [adjustment on remote-control panel]** to modulate gas furnace burner to maintain space temperature.
 3. Remote Setback: Adjustable room thermostat selected by timer, set at **[50 deg F (10 deg C)] <Insert temperature>**; cycles supply fan and gas furnace burner to maintain space temperature.
 4. Burner Control: **[Two] [Four] [steps of control] [Modulating]**.
- H. Rotary Heat-Exchanger Control:
1. Sequence with refrigeration system controls and heating controls.
 2. For operation of rotary heat exchanger itself, see "Rotary Heat Exchanger" Article.
- I. Electric-Resistance Heat Controls:
1. **[Factory-mounted sensor in unit discharge] [Remote sensor for field installation in supply-air duct]** with sensor adjustment located in control panel to control electric coil to maintain temperature.

2. Wall-mounted, space-temperature sensor with **[temperature adjustment] [unit-mounted temperature adjustment] [adjustment on remote-control panel]** to control electric coil to maintain temperature.
 3. Capacity Controls: **[On/off] [Multiple steps] [Modulating SCR] <Insert type>**.
 - J. **[Hot-Water] [and] [Steam]** Coil Controls, Discharge Temperature Sensor: **[Factory-mounted sensor in unit discharge] [Remote sensor for field installation in supply-air duct]** with sensor adjustment located in control panel to modulate factory-**[mounted] [furnished]** coil control valve to maintain temperature.
 - K. **[Hot-Water] [and] [Steam]** Coil Controls, Space Temperature Sensor: With **[temperature adjustment] [unit-mounted temperature adjustment] [adjustment on remote-control panel]** to modulate factory-**[mounted] [furnished]** coil control valve to maintain temperature.
 - L. Damper Controls: Space-pressure sensor modulates outdoor- and relief-air dampers to maintain a positive pressure in space at a minimum of **[0.05 inch wg (12.4 Pa)] <Insert value>** with respect to outdoor reference.
 - M. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Links shall include 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 operation.
 - d. Furnace operation.
 - N. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.
 1. Hardwired Points:
 - a. Monitoring: On-off status, **[common trouble alarm] <Insert monitoring point>**.
 - b. Control: On-off operation, **[space temperature set-point adjustment] [supply temperature set-point adjustment] [space humidity set-point adjustment] [space pressure set-point adjustment] <Insert control point>**.
 2. **[ASHRAE 135 (BACnet)] [LonTalk] [Modbus] [Industry-accepted, open-protocol] <Insert type of interface>** communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the DDC system for HVAC.
 - O. **<Insert additional control sequences and requirements>**.
- 2.14 ROOF CURBS
- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC." Roof curbs with vibration isolators and wind restraints are specified in Section 230548.13 "Vibration Controls for HVAC."

- B. Materials: Galvanized steel with corrosion-resistant coating, watertight gaskets, and factory-installed wood nailer; complying with National Roofing Contractors Association manuals for the specific type of roofing applicable to the Project.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C1071, Type I or II.
 - b. Thickness: **[1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert dimension>**.
 - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service air velocity.
- C. Curb Dimensions: Height of **[14 inches (355 mm)] [24 inches (610 mm)] [36 inches (910 mm)] <Insert dimension>**.**[Provide adaptable horizontal dimensions as required for existing roof openings.]**
- D. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

2.15 INTAKE AND RELIEF OPENINGS

- A. Type: Manufacturer's standard hood or louver, including moisture eliminator, at all unit intake and relief openings.
- B. Materials: Match material and finish of casing exterior.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.16 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209 (ASTM B209M).
- E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

- F. Corrosion-Resistant Coating: Coat **[casing] [coils] [and] [fan guards]** with a corrosion-resistant coating capable of withstanding a **[3,000] <Insert time>**-hour salt-spray test in accordance with ASTM B117.
1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
 - c. ASTM D3359 for cross-hatch adhesion of 5B.
 2. Application: **[Immersion] [Spray]**.
 3. Thickness: **[1 mil] <Insert measurement>**.
 4. Gloss: Minimum gloss of 50 gloss units on a single angle 60-degree meter.

2.17 SOURCE QUALITY CONTROL

- A. AHRI 920: Manufacturer to certify that performance ratings are in accordance with AHRI 920 if AHRI 920 certification program is not in place. Provide AHRI 920 certification if AHRI 920 certification program is in place.
- B. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label unit fan sound ratings in accordance with AHRI 260 or AMCA 311.
- C. Fan Aerodynamic Performance Rating: Test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency.
1. **[Fan Aerodynamic Performance Rating: Test and rate fan performance in accordance with AMCA 210.]**
 2. **[AMCA Fan Aerodynamic Certification Rating: Test, rate, and label, in accordance with AMCA 211.]**
- D. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.
- E. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.
- F. Damper Leakage and Air Performance:
1. **[Damper Rating: Test and rate dampers for leakage and air performance in accordance with AMCA 510.]**
 2. **[AMCA Damper Certification: Test, rate, and label in accordance with AMCA 511.]**
- G. Water Coils: Factory tested to 300 psig (2070 kPa) in accordance with AHRI 410 and ASHRAE 33.
- H. Refrigerant Coils: Factory tested to minimum **[300 psig (2070 kPa)] [450 psig (3105 kPa)]** internal pressure and to minimum 300 psig (2070 kPa) internal pressure while under water, in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION – NOT USED

END OF SECTION 237433

SECTION 238123.13 - COMPUTER-ROOM AIR-CONDITIONERS, CEILING-MOUNTED UNITS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. APC by Schneider Electric.
 2. Compu-Aire, Inc.
 3. Liebert; a brand of Emerson Electric Co.
 4. Stulz-ATS.
 5. **<Insert manufacturer's name>.**

2.2 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following: Paints and Coatings: VOC content and emissions evaluation.
- B. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."
- 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. ASHRAE Compliance:
1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems." ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
- E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- F. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.3 MANUFACTURED UNITS

- A. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls.
1. Mounting Configuration: Exposed in the space.
 2. Mounting Configuration: Fit T-bar in lay-in ceiling opening.
 3. Mounting Configuration: Concealed above a hard ceiling.
- B. Cabinet: Galvanized steel serviceable from one side, with baked-enamel finish, insulated with 1/2-inch- (13-mm-) thick duct liner, and mounting bracket attached to the unit.
1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches (610 by 1220 mm), with filter.
 2. Unit with supply and return collars for ducting in the field.
 3. Unit with 24-by-48-inch (610-by-1220-mm) air distribution plenum, with integral MERV 8 filter and three-way air distribution.
 4. Unit with two-speed, centrifugal direct-drive fan.

5. Unit with single-speed, centrifugal belt-driven fan.
 6. Unit with high static blower assembly consisting of field-attached blower box with double-inlet, centrifugal belt-driven fan; with single-speed motor mounted on an adjustable base, and providing up to 2 inches wc (500 Pa) of external pressure.
 7. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Supply-Air Fan:
1. Forward curved, double width, double inlet, centrifugal, with adjustable V-belt drive.
 2. Plug/plenum, single inlet, direct drive, electronically commutated, and variable speed.
 3. Fan should operate continuously.
- D. Refrigeration System:
1. Compressor: Scroll, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
 2. Refrigeration Circuit Components:
 - a. Low-pressure switch.
 - b. Manually reset, high-pressure switch.
 - c. Thermal-expansion valve with external equalizer.
 - d. Sight glass with moisture indicator.
 - e. Service shutoff valves.
 - f. Charging valves.
 - g. Hot-gas bypass.
 - h. Refrigerant charge.
 3. Refrigerant: **[R-407C] [or] [R-410A] <Insert type>**.
 4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 5. Refrigerant line sets precharged in lengths of **[15 feet (4.6 m)] [30 feet (9.0 m)]** and of sufficient length to serve the unit from its condensing unit.
 6. Refrigerant line-sweat-adapter kit to permit field brazing of refrigerant lines.
 - a. Mount stainless-steel drain pan **[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir]** under coil assembly.
 7. Integral, Water-Cooled Refrigerant Condenser: **[Coaxial, counterflow, tube-in-tube] [Brazed-plate]** type with liquid-line stop valve and head-pressure-actuated, water-regulating valve.
 - a. Cooling Medium: **[Water] [Glycol solution]**.
 8. Remote, Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with direct-drive, **[propeller] [centrifugal]** fan.
 9. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.
- E. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with two-way control valve.
1. Cooling Medium: **[Water] [Glycol solution]**.
 2. Mount stainless-steel drain pan **[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir]** under coil assembly.
- F. Hot-Water Reheat: Copper-tube, aluminum-fin coil with two-way, modulating control valve and cleanable Y-strainer.

- G. Electric-Resistance Reheat Coil:
 - 1. Finned-tube electric elements with contactor.
 - 2. Dehumidification relay.
 - 3. High-temperature-limit switches.
 - 4. SCR to proportionally control the reheat elements providing precise temperature control.
- H. Filter: 1-inch- (25-mm-) thick, disposable, glass-fiber media.
 - 1. Initial Resistance: <Insert number> inches wg (Pa).
 - 2. Recommended Final Resistance: <Insert number> inches wg ((Pa)).
 - 3. Pre-Filter Minimum Efficiency Reporting Value and Average Arrestance:
 - a. MERV Rating: [MERV 1] [MERV 2] [MERV 3] [MERV 4] <Insert value> and corresponding average arrestance according to ASHRAE 52.2.
 - 4. Pre-Filter Minimum Efficiency Reporting Value:
 - a. [MERV 6] <Insert value> according to ASHRAE 52.2.
 - 5. Filter Minimum Efficiency Reporting Value:
 - a. MERV Rating: [MERV 6] [MERV 13] <Insert value> according to ASHRAE 52.2.
- I. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
 - 1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
 - 2. Control: Fully modulating to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
 - 3. Drain Cycle: Field-adjustable drain duration and drain interval.
- J. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- K. Single point power kit permitting single electrical feed to the evaporator and condensing unit of a close-coupled system.
- L. Epoxy-coated, step-down transformer suitable for mounting on the outdoor condensing unit to provide it with 277-V input power.
- M. Control System:
 - 1. Microprocessor [unit] [remote]-mounted panel.
 - 2. Fan contactor.
 - 3. Compressor contactor.
 - 4. Compressor start capacitor.
 - 5. Control transformer with circuit breaker.
 - 6. Solid-state temperature-[and humidity]-control modules.
 - 7. Humidity contactor.
 - 8. Time-delay relay.
 - 9. Heating contactor.
 - 10. Smoke sensor.
 - 11. Filter clog switch.
 - 12. Alarm contacts.
 - 13. High-temperature thermostat.

14. Solid-state, wall-mounted control panel with start-stop switch[, **adjustable humidity set point,**] **[remote temperature sensors]** **[remote humidity sensors]** and adjustable temperature set point.
15. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.

N. Fan Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
 - b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - c. **<Insert unique motor characteristics>.**

PART 3 - EXECUTION – NOT USED

END OF SECTION 238123.13

SECTION 238129 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following:
 - 1. Adhesives: VOC content and emissions evaluation.
 - 2. Sealants: VOC content and emissions evaluation.
 - 3. Paints and Coatings: VOC content and emissions evaluation.
- B. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."

2.2 VRF HVAC SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Global Corporation.
 - 2. Daikin Applied.
 - 3. Fujitec America, Inc.
 - 4. Johnson Controls, Inc.
 - 5. LG Electronics USA, Inc.; LG Electronics Inc.
 - 6. Mitsubishi Electric & Electronics USA, Inc.(PCC Preferred Vendor)
 - 7. Panasonic Corporation of North America.
 - 8. RectorSeal HVAC; a CSW Industrials Company.
 - 9. Samsung HVAC.
 - 10. Trane Inc.
 - 11. Frederich Fujitsu
 - 12. **<Insert manufacturer's name>.**
- B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:
 - 1. Indoor and outdoor units, including accessories.
 - 2. Controls and software.
 - 3. HRCUs.
 - 4. Refrigerant isolation valves.
 - 5. Specialty refrigerant pipe fittings.
 - 6. **<Insert products>.**

2.3 SYSTEM DESCRIPTION

- A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, **[HRCUs]**, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
 - 1. **[Two-pipe] [or] [three-pipe]** system design.
 - 2. System(s) operation, **[air-conditioning] [heat pump] [or] [heat recovery]** as indicated on Drawings.
 - 3. Each system with one refrigerant circuit shared by all indoor units connected to system.

- 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. AHRI Compliance: System and equipment performance certified according to AHRI 1230[**and products listed in AHRI directory**].
- D. ASHRAE Compliance:
 - 1. ASHRAE 15: For safety code for mechanical refrigeration.
 - 2. ASHRAE 62.1: For indoor air quality.
 - 3. ASHRAE 135: For control network protocol with remote communication.
 - 4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.
- E. UL Compliance: Comply with UL 1995.

2.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional [**engineer**] [**specialist**], as defined in Section 014000 "Quality Requirements," to design complete and operational VRF HVAC system(s) complying with requirements indicated.
 - 1. Provide system refrigerant calculations.
 - a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
 - b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.
 - 2. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.
 - 3. System Refrigerant Piping and Tubing:
 - a. Arrangement: Arrange piping to interconnect indoor units[, **HRCUs**,] and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.
 - b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.
 - c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.
 - 4. System Controls:
 - a. Network arrangement.
 - b. Network interface with other building systems.
 - c. Product selection.
 - d. Sizing.
- B. Service Access:
 - 1. Provide and document service access requirements.
 - 2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
 - 3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
 - 4. If less than full and unrestricted access is provided, locate components within an 18-inch (450-mm) reach of the finished assembly.

5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
6. Comply with OSHA regulations.
- C. System Design and Installation Requirements:
 1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
 2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.
- D. System Adaptability to Future Changes: Arrange and size system refrigerant piping to accommodate future changes to system without having to resize and replace existing refrigerant piping.
 1. Future changes to system(s) indicated on Drawings.
 2. Each branch circuit shall accommodate addition of **[one] [two] <Insert number>** indoor unit(s) with unit capacity equal to **[largest] [smallest] [average] <Insert capacity requirement>** indoor unit connected to the branch circuit.
 3. Each branch circuit shall accommodate deletion of **[one] [two] <Insert number>** indoor unit(s) with unit capacity equal to **[largest] [smallest] [average] <Insert capacity requirement>** indoor unit connected to the branch circuit.
 4. **<Insert requirements for future changes>**.
- E. Isolation of Equipment: Provide isolation valves to isolate each **[HRCU,]** indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.
- F. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:
 1. Not less than **[50] [60] <Insert number>** percent.
 2. Not more than **[130] [150] <Insert number>** percent.
 3. Range acceptable to manufacturer.
- G. System Turndown: Stable operation down to **[20] <Insert number>** percent of outdoor-unit capacity.
- H. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.
- I. Outdoor Conditions:
 1. Suitable for outdoor ambient conditions encountered.
 - a. Design equipment and supports to withstand wind loads of governing code **[and ASCE/SEI 7] <Insert requirement>**.
 - b. Design equipment and supports to withstand snow and ice loads of governing code **[and ASCE/SEI 7] <Insert requirement>**.
 - c. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.
 2. Maximum System Operating Outdoor Temperature: **[See Drawings] <Insert value>**.
 3. Minimum System Operating Outdoor Temperature: **[See Drawings] <Insert value>**.

- J. Seismic Performance: VRF HVAC system(s) shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
1. The term "withstand" means "the system 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] [1.0] <Insert value>.
 3. <Insert requirements for Component Amplification Factor and Component Response Modification Factor>.
- K. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
1. Indoor: [See Drawings.] [Within design guidelines of "2015 ASHRAE HANDBOOK-HVAC Applications."] <Insert values.>
 2. Outdoor: [See Drawings] [Within ordinance of governing authorities] <Insert values>.
- L. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

2.5 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING

- A. Description: Factory-assembled[**and -tested**] complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
- B. Cabinet:
1. Material: [Galvanized] [or] [painted] steel.
 2. Insulation: Manufacturer's standard internal insulation[, **complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
 3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
 4. Mounting: Manufacturer-designed provisions for field installation.
 5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. DX Coil Assembly:
1. Coil Casing: Aluminum, galvanized, or stainless steel.
 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
 3. Coil Tubes: Copper, of diameter and thickness required by performance.
 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
 5. Unit Internal Tubing: Copper tubing with brazed joints.
 6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 7. Field Piping Connections: Manufacturer's standard.
 8. Factory Charge: Dehydrated air or nitrogen.
 9. Testing: Factory pressure tested and verified to be without leaks.
- D. Drain Assembly:
1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
 2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
 3. Field Piping Connection: Non-ferrous material[**with threaded NPT**].

E. Fan and Motor Assembly:

1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
 - d. Wheels statically and dynamically balanced.
2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2. Efficiency: **[ASHRAE 52.2, MERV 7] [ASHRAE 52.2, MERV 11] [ASHRAE 52.2, MERV 13] <Insert efficiency>**.
3. Media: **[If more than one filter type is indicated, Contractor has option to choose.]**
 - a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
 - b. Washable: Manufacturer's standard filter with antimicrobial treatment.

G. Unit Accessories:

1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control sized to allow sequence of operation indicated on Drawings.
2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
3. **<Insert accessories>**.

H. Unit Controls:

1. Enclosure: Metal, suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:
 - a. Unit inlet air temperature.
 - b. Coil entering refrigerant temperature.
 - c. Coil leaving refrigerant temperature.
 - d. **<Insert sensor>**.
4. Field-Customizable I/O Capability:
 - a. Analog Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - b. Digital Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - c. Digital Outputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
5. Features and Functions:
 - a. Self-diagnostics.
 - b. Time delay.

- c. Auto-restart.
 - d. External static pressure control.
 - e. Auto operation mode.
 - f. Manual operation mode.
 - g. Filter service notification.
 - h. Power consumption display.
 - i. Drain assembly high water level safety shutdown and notification.
 - j. Run test switch.
 - k. **<Insert function>**.
 - 6. Communication: Network communication with other indoor and outdoor units.
 - 7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - I. Unit Electrical:
 - 1. Enclosure: Metal, suitable for indoor locations.
 - 2. Field Connection: Single point connection to power unit and integral controls.
 - 3. Disconnecting Means: Factory-mounted circuit breaker or switch.
 - 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
 - 5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 6. Raceways: Enclose line voltage wiring in **[metal]** raceways.
- 2.6 INDOOR, CONCEALED, FLOOR-MOUNTED UNITS FOR DUCTING
- A. Description: Factory-assembled[**and -tested**] complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
 - B. Cabinet:
 - 1. Material: **[Galvanized] [or] [painted]** steel.
 - 2. Insulation: Manufacturer's standard internal insulation[, **complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
 - 3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
 - 4. Mounting: Manufacturer-designed provisions for field installation.
 - 5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
 - C. DX Coil Assembly:
 - 1. Coil Casing: Aluminum, galvanized, or stainless steel.
 - 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
 - 3. Coil Tubes: Copper, of diameter and thickness required by performance.
 - 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
 - 5. Unit Internal Tubing: Copper tubing with brazed joints.
 - 6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 - 7. Field Piping Connections: Manufacturer's standard.
 - 8. Factory Charge: Dehydrated air or nitrogen.
 - 9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Field Piping Connection: Non-ferrous material[**with threaded NPT**].

E. Fan and Motor Assembly:

1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Materials: Non-ferrous components or ferrous components with corrosion resistant finish.
 - d. Statically and dynamically balanced.
2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2. Efficiency: **[ASHRAE 52.2, MERV 7] [ASHRAE 52.2, MERV 11] [ASHRAE 52.2, MERV 13] <Insert efficiency>**.
3. Media:[**If more than one filter type is indicated, Contractor has option to choose.**]
 - a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
 - b. Washable: Manufacturer's standard filter with antimicrobial treatment.

G. Unit Accessories:

1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control sized to allow sequence of operation indicated on Drawings.
2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
3. **<Insert accessories>**.

H. Unit Controls:

1. Enclosure: Metal, suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:
 - a. Unit inlet air temperature.
 - b. Coil entering refrigerant temperature.
 - c. Coil leaving refrigerant temperature.
 - d. **<Insert sensor>**.
4. Field-Customizable I/O Capability:
 - a. Analog Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.

- b. Digital Inputs: **[Two]** **[Three]** **[Four]** **<Insert number>** for use in customizable control strategies.
 - c. Digital Outputs: **[Two]** **[Three]** **[Four]** **<Insert number>** for use in customizable control strategies.
 - 5. Features and Functions:
 - a. Self-diagnostics.
 - b. Time delay, auto-restart.
 - c. External static pressure control.
 - d. Auto operation mode.
 - e. Manual operation mode.
 - f. Filter service notification.
 - g. Power consumption display.
 - h. Drain assembly high water level safety shutdown and notification.
 - i. Run test switch.
 - j. **<Insert function>**.
 - 6. Communication: Network communication with other indoor units and outdoor unit(s).
 - 7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - I. Unit Electrical:
 - 1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
 - 2. Field Connection: Single point connection to power unit and integral controls.
 - 3. Disconnecting Means: Factory-mounted circuit breaker or switch.
 - 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
 - 5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 6. Raceways: Enclose line voltage wiring in **[metal]** raceways.
- 2.7 INDOOR, EXPOSED, FLOOR-MOUNTED UNITS
- A. Description: Factory-assembled[**and -tested**] complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
 - B. Cabinet:
 - 1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
 - 2. Insulation: Manufacturer's standard internal insulation[, **complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
 - 3. Mounting: Manufacturer-designed provisions for field installation.
 - 4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
 - C. DX Coil Assembly:
 - 1. Coil Casing: Aluminum, galvanized, or stainless steel.
 - 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
 - 3. Coil Tubes: Copper, of diameter and thickness required by performance.
 - 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
 - 5. Unit Internal Tubing: Copper tubing with brazed joints.

6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 7. Field Piping Connections: Manufacturer's standard.
 8. Factory Charge: Dehydrated air or nitrogen.
 9. Testing: Factory pressure tested and verified to be without leaks.
- D. Drain Assembly:
1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
 2. Condensate Removal: Gravity.
 - a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
 3. Field Piping Connection: Non-ferrous material[**with threaded NPT**].
- E. Fan and Motor Assembly:
1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Materials: Non-ferrous components or ferrous components with corrosion-resistant finish.
 - d. Statically and dynamically balanced.
 2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
 3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
 5. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Filter Assembly:
1. Access: Front, to accommodate filter replacement without the need for tools.
 2. Efficiency: **<Insert efficiency>**.
 3. Washable Media: Manufacturer's standard filter with antimicrobial treatment.
- G. Grille Assembly: Manufacturer's standard discharge grille[**with field-adjustable air pattern**] mounted in top of unit cabinet.
- H. Unit Accessories:
1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
 2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.
 3. **<Insert accessories>**.
- I. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
 2. Factory-Installed Controller: Configurable digital control.
 3. Factory-Installed Sensors:
 - a. Unit inlet air temperature.
 - b. Coil entering refrigerant temperature.
 - c. Coil leaving refrigerant temperature.
 - d. **<Insert sensor>**.

4. Field-Customizable I/O Capability:
 - a. Analog Inputs: **[Two]** **[Three]** **[Four]** **<Insert number>** for use in customizable control strategies.
 - b. Digital Inputs: **[Two]** **[Three]** **[Four]** **<Insert number>** for use in customizable control strategies.
 - c. Digital Outputs: **[Two]** **[Three]** **[Four]** **<Insert number>** for use in customizable control strategies.
5. Features and Functions:
 - a. Self-diagnostics.
 - b. Time delay.
 - c. Auto-restart.
 - d. External static pressure control.
 - e. Auto operation mode.
 - f. Manual operation mode.
 - g. Filter service notification
 - h. Power consumption display.
 - i. Drain assembly high water level safety shutdown and notification.
 - j. Run test switch.
 - k. **<Insert function>**.
6. Communication: Network communication with other indoor units and outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

J. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in **[metal]** raceways.

2.8 INDOOR, EXPOSED, WALL-MOUNTED UNITS

- A. Description: Factory-assembled[**and -tested**] complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
- B. Cabinet:
 1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
 2. Insulation: Manufacturer's standard internal insulation[, **complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
 3. Mounting: Manufacturer-designed provisions for field installation.
 4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Gravity.
 - a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
3. Field Piping Connection: Non-ferrous material[**with threaded NPT**].

E. Fan and Motor Assembly:

1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
 - d. Wheels statically and dynamically balanced.
2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Front, to accommodate filter replacement without the need for tools.
2. Efficiency: **<Insert efficiency>**.
3. Washable Media: Manufacturer's standard filter with antimicrobial treatment.

G. Grille Assembly: Manufacturer's standard discharge grille[**with field-adjustable air pattern**] mounted in top [**or front face**] of unit cabinet.

H. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.
3. **<Insert accessories>**.

I. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: **[Unit inlet air temperature] [Coil entering refrigerant temperature] [Coil leaving refrigerant temperature] <Insert sensor>**.
4. Field-Customizable I/O Capability:
 - a. Analog Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - b. Digital Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - c. Digital Outputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
5. Features and Functions: Self-diagnostics, time delay, auto-restart[, **external static pressure control**] [, **auto operation mode**] [, **manual operation mode**] [, **filter service notification**] [, **power consumption display**] [, **drain assembly high water level safety shutdown and notification**] [, **run test switch**] **<Insert function>**.
6. Communication: Network communication with other indoor units and outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

J. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in **[metal]** raceways to comply with NFPA 70.

2.9 INDOOR, RECESSED, CEILING-MOUNTED UNITS

- A. Description: Factory-assembled[**and -tested**] complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation[, **complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.

5. Internal Tubing: Copper tubing with brazed joints.
 6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 7. Field Piping Connections: Manufacturer's standard.
 8. Factory Charge: Dehydrated air or nitrogen.
 9. Testing: Factory pressure tested and verified to be without leaks.
- D. Drain Assembly:
1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
 2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
 3. Field Piping Connection: Non-ferrous material[**with threaded NPT**].
- E. Fan and Motor Assembly:
1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
 - d. Wheels statically and dynamically balanced.
 2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
 3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
 5. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Filter Assembly:
1. Access: Bottom, to accommodate filter replacement without the need for tools.
 2. Efficiency: **[ASHRAE 52.2, MERV 7] [ASHRAE 52.2, MERV 11] [ASHRAE 52.2, MERV 13] <Insert efficiency>**.
 3. Media:[**If more than one filter type is indicated, Contractor has option to choose.**]
 - a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
 - b. Washable: Manufacturer's standard filter with antimicrobial treatment.
- G. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.
1. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
 - a. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
 - b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.
 2. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
 3. Additional Branch Supply Duct Connection: Sheet metal knockout for optional connection to one additional supply branch duct.
- H. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.
- I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

J. Unit Accessories:

1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control to satisfy unit control sequence of operation indicated on Drawings.
2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
3. **<Insert accessories>**.

K. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: **[Unit inlet air temperature] [Coil entering refrigerant temperature] [Coil leaving refrigerant temperature] <Insert sensor>**.
4. Field-Customizable I/O Capability:
 - a. Analog Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - b. Digital Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - c. Digital Outputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
5. Features and Functions: Self-diagnostics, time delay, auto-restart[, **external static pressure control**] [, **auto operation mode**] [, **manual operation mode**] [, **filter service notification**] [, **power consumption display**] [, **drain assembly high water level safety shutdown and notification**] [, **run test switch**] **<Insert function>**.
6. Communication: Network communication with other indoor units and outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

L. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in **[metal]** raceways to comply with NFPA 70.

2.10 INDOOR, SUSPENDED, CEILING-MOUNTED UNITS

A. Description: Factory-assembled[**and -tested**] complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation[, **complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Internal Tubing: Copper tubing with brazed joints.
6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Gravity.
 - a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
3. Field Piping Connection: Non-ferrous material[**with threaded NPT**].

E. Fan and Motor Assembly:

1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
 - d. Wheels statically and dynamically balanced.
2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Front, to accommodate filter replacement without the need for tools.
2. Efficiency: **<Insert efficiency>**.
3. Washable Media: Manufacturer's standard filter with antimicrobial treatment.

G. Discharge-Air Grille Assembly: Mounted in front of unit cabinet.

1. Discharge Pattern: One-way throw.
2. Discharge Pattern Adjustment: Field-adjustable limits for range of pattern.
3. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

H. Return-Air Grille Assembly: Manufacturer's standard.

I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

J. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.
3. **<Insert accessories>**.

K. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: **[Unit inlet air temperature] [Coil entering refrigerant temperature] [Coil leaving refrigerant temperature] <Insert sensor>**.
4. Field-Customizable I/O Capability:
 - a. Analog Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - b. Digital Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - c. Digital Outputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
5. Features and Functions: Self-diagnostics, time delay, auto-restart[, **external static pressure control**] [, **auto operation mode**] [, **manual operation mode**] [, **filter service notification**] [, **power consumption display**] [, **drain assembly high water level safety shutdown and notification**] [, **run test switch**] **<Insert function>**.
6. Communication: Network communication with other indoor units and outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

L. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in **[metal]** raceways to comply with NFPA 70.

2.11 INDOOR, DEDICATED OUTDOOR AIR VENTILATION UNITS

- A. Description: Factory-assembled[**and -tested**] complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

1. Specially designed for up to 100 percent outdoor air entering unit.

B. Cabinet:

1. Material: **[Galvanized] [or] [painted]** steel.
2. Insulation: Manufacturer's standard internal insulation[, **complying with ASHRAE 62.1,**] to provide thermal resistance and prevent condensation.
3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4. Mounting: Manufacturer-designed provisions for field installation.
5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. DX Coil Assembly for Reheat Applications: Provide units with a reheat coil where indicated on Drawings.

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

E. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Field Piping Connection: Non-ferrous material[**with threaded NPT**].

F. Fan and Motor Assembly:

1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
 - d. Wheels statically and dynamically balanced.
2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

G. Filter Assembly:

1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2. Efficiency: **[ASHRAE 52.2, MERV 7] [ASHRAE 52.2, MERV 11] [ASHRAE 52.2, MERV 13] <Insert efficiency>**.

3. Replaceable Media: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

H. Unit Accessories:

1. Motorized Inlet Damper Kit: Low-leakage damper with spring return electric actuator to fail closed on loss of power. Damper controlled by unit to open when unit is operating and close when unit off.
2. **<Insert accessories>**.

I. Unit Controls:

1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: **[Coil entering refrigerant temperature] [Coil leaving refrigerant temperature] [Unit entering-air temperature] [Unit leaving-air temperature] [Unit entering-air relative humidity] [Unit leaving-air relative humidity] <Insert sensor>**.
4. Field-Customizable I/O Capability:
 - a. Analog Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - b. Digital Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - c. Digital Outputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
5. Features and Functions: Self-diagnostics, time delay, auto-restart[, **external static pressure control**] [, **auto operation mode**] [, **manual operation mode**] [, **filter service notification**] [, **power consumption display**] [, **drain assembly high water level safety shutdown and notification**] [, **run test switch**] **<Insert function>**.
6. Communication: Network communication with other indoor units and outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

J. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in **[metal]** raceways to comply with NFPA 70.

2.12 INDOOR, ENERGY RECOVERY VENTILATOR

- A. Description: Factory-assembled[**and -tested**] complete unit with components, wiring, and controls required for mating to ductwork, power, and controls field connections.
- B. Cabinet:
 1. Material: Galvanized steel.
 2. Insulation: Manufacturer's standard internal insulation[, **complying with ASHRAE 62.1**].

3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
 4. Mounting: Manufacturer-designed provisions for field installation.
 5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. Damper Assemblies:
1. Outdoor Air Intake and Exhaust Air Discharge:
 - a. Low-leakage damper with spring return electric actuator to fail closed on loss of power.
 - b. Damper controlled by unit to open when unit is operating and close when unit off.
 2. Energy Recovery Heat-Exchanger Bypass:
 - a. Low leakage damper with electric actuator with integral controls to bypass outdoor air around the energy recovery heat exchanger during times of favorable weather, and there is no energy-saving benefit to circulate air across the energy recovery heat exchanger.
- D. Fan and Motor Assemblies: Separate fan and motor assemblies for supply and exhaust airstreams with control for equal airflow.
1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
 - c. Wheels statically and dynamically balanced.
 2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
 3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least [50] <Insert number> percent.
 5. Vibration Control: Integral isolation to dampen vibration transmission.
- E. Filter Assemblies: Separate filter assemblies for outdoor air and exhaust airstreams entering energy recovery heat exchanger.
1. Access: To accommodate filter replacement without the need for tools.
 2. Efficiency: [ASHRAE 52.2, MERV 7] <Insert efficiency>.
 3. Replaceable Media: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
- F. Energy Recovery Heat Exchanger:
1. Total (sensible and latent) energy exchange between outdoor air and exhaust airstreams with performance indicated on Drawings.
 2. Fixed element with no moving parts.
 3. AHRI 1060 certified and bearing the AHRI label.
- G. Unit Accessories:
1. Electric Duct Preheater:
 - a. Heater operation interlocked with energy recovery ventilator unit.
 - b. Heater with integral controls to control outdoor air temperature entering energy recovery ventilator unit to a temperature set-point determined by energy recovery ventilator unit manufacturer.

- c. Listed and labeled.
 - 2. **<Insert accessories>**.
 - H. Unit Controls:
 - 1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
 - 2. Factory-Installed Controller: Configurable digital control.
 - 3. Factory-Installed Sensors:
 - a. Unit entering outdoor air temperature.
 - b. Unit leaving supply air temperature.
 - c. Unit entering exhaust air temperature.
 - d. Unit leaving exhaust air temperature.
 - e. Unit entering outdoor air relative humidity.
 - f. Unit leaving supply air relative humidity.
 - g. Unit entering exhaust air relative humidity.
 - h. Unit leaving exhaust air relative humidity.
 - i. **<Insert sensor>**.
 - 4. Field-Customizable I/O Capability:
 - a. Analog Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - b. Digital Inputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - c. Digital Outputs: **[Two] [Three] [Four] <Insert number>** for use in customizable control strategies.
 - 5. Features and Functions: Self-diagnostics, time delay, auto-restart[, **external static pressure control**] [, **local auto operation mode**] [, **auto operation through remote signal**] [, **manual operation mode**] [, **filter service notification**] [, **power consumption display**] [, **run test switch**] **<Insert function>**.
 - 6. Communication: Network communication with other indoor units and outdoor unit(s).
 - 7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - I. Unit Electrical:
 - 1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
 - 2. Field Connection: Single point connection to power entire unit and integral controls.
 - 3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
 - 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
 - 5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 6. Raceways: Enclose line voltage wiring in **[metal]** raceways to comply with NFPA 70.
- 2.13 OUTDOOR, AIR-SOURCE HEAT-PUMP UNITS
- A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
 - 1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.

2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
 3. All units installed shall be from the same product development generation.
- B. Cabinet:
1. Galvanized steel and coated with a corrosion-resistant finish.
 - a. Coating with documented salt spray test performance of [1000] <Insert number> hours according ASTM B117 surface scratch test (SST) procedure.
 2. Mounting: Manufacturer-designed provisions for field installation.
 3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. Compressor and Motor Assembly:
1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to [15] <Insert number> percent of rated capacity.
 2. Protection: Integral protection against the following:
 - a. High refrigerant pressure.
 - b. Low oil level.
 - c. High oil temperature.
 - d. Thermal and overload.
 - e. Voltage fluctuations.
 - f. Phase failure and phase reversal.
 - g. Short cycling.
 - h. <Insert safeties>.
 3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
 4. Vibration Control: Integral isolation to dampen vibration transmission.
 5. Oil management system to ensure safe and proper lubrication over entire operating range.
 6. Crankcase heaters with integral control to maintain safe operating temperature.
 7. Fusible plug.
- D. Condenser Coil Assembly:
1. Plate Fin Coils:
 - a. Casing: Aluminum, galvanized, or stainless steel.
 - b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
 - c. Tubes: Copper, of diameter and thickness required by performance.
 2. Aluminum Microchannel Coils:
 - a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
 - b. Single- or multiple-pass arrangement.
 - c. Construct fins, tubes, and header manifolds of aluminum alloy.
 3. Coating: [None] [Corrosion resistant].
 4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
- E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.
 - a. Direct-drive arrangement.
 - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
 - c. **[Statically and]**dynamically balanced.
 2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
 3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
 4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 5. Speed Settings and Control: Variable speed with a speed range of least **[75] <Insert number>** percent.
 6. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
- G. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
 2. Factory-Installed Controller: Configurable digital control.
 3. Factory-Installed Sensors:
 - a. Refrigerant suction temperature.
 - b. Refrigerant discharge temperature.
 - c. Outdoor air temperature.
 - d. Refrigerant high pressure.
 - e. Refrigerant low pressure.
 - f. Oil level.
 - g. **<Insert sensor>**.
 4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection[, **auto operation mode**] [, **manual operation mode**] [, **night setback control**] [, **power consumption display**] [, **run test switch**] [**equalize run time between multiple same components**] **<Insert function>**.
 5. Communication: Network communication with indoor units and other outdoor unit(s).
 6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
- H. Unit Electrical:
1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
 2. Field Connection: Single point connection to power entire unit and integral controls.
 3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
 5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 6. Raceways: Enclose line voltage wiring in **[metal]**raceways to comply with NFPA 70.
- I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for **[1000] <Insert number>** hours according ASTM B117.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.14 OUTDOOR, AIR-SOURCE HEAT RECOVERY UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.
 - a. Coating with documented salt spray test performance of [1000] <Insert number> hours according ASTM B117 surface scratch test (SST) procedure.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to [15] <Insert number> percent of rated capacity.
2. Protection: Integral protection against the following:
 - a. High refrigerant pressure.
 - b. Low oil level.
 - c. High oil temperature.
 - d. Thermal and overload.
 - e. Voltage fluctuations.
 - f. Phase failure and phase reversal.
 - g. Short cycling.
 - h. <Insert safeties>.
3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:
 - a. Casing: Aluminum, galvanized, or stainless steel.

- b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
 - c. Tubes: Copper, of diameter and thickness required by performance.
 - 2. Aluminum Microchannel Coils:
 - a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
 - b. Single- or multiple-pass arrangement.
 - c. Construct fins, tubes, and header manifolds of aluminum alloy.
 - 3. Coating: **[None] [Corrosion resistant]**.
 - 4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
- E. Condenser Fan and Motor Assembly:
 - 1. Fan(s): Propeller type.
 - a. Direct-drive arrangement.
 - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
 - c. **[Statically and]**dynamically balanced.
 - 2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
 - 3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
 - 4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 - 5. Speed Settings and Control: Variable speed with a speed range of least **[75] <Insert number>** percent.
 - 6. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
- G. Unit Controls:
 - 1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
 - 2. Factory-Installed Controller: Configurable digital control.
 - 3. Factory-Installed Sensors:
 - a. Refrigerant suction temperature.
 - b. Refrigerant discharge temperature.
 - c. Outdoor air temperature.
 - d. Refrigerant high pressure.
 - e. Refrigerant low pressure.
 - f. Oil level.
 - g. **<Insert sensor>**.
 - 4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection[, **auto operation mode**] [, **manual operation mode**] [, **night setback control**] [, **power consumption display**] [, **run test switch**] [**equalize run time between multiple same components**] **<Insert function>**.
 - 5. Communication: Network communication with indoor units and other outdoor unit(s).
 - 6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in [metal] raceways to comply with NFPA 70.

I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevent corrosion when exposed to salt spray test for [1000] <Insert number> hours according ASTM B117.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.15 HEAT RECOVERY CONTROL UNITS (HRCUs)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. Refrigerant Liquid and Suction Piping Insulated and Routed Separately. Attached to uni-strut via crush clamps.
4. Communication Wiring between Evaporator units and Condensing Units needs to be in conduit. Points of connection need toggle switches/disconnects for safety.
5. Condensate Drains by Gravity preferred to Pumped Condensate.

B. Cabinet:

1. Galvanized-steel construction.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

D. Refrigeration Assemblies and Specialties:

1. Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
2. Each refrigerant branch circuit shall have refrigerant control valve(s) to control refrigerant flow.

3. Spares: Each heat recovery control unit shall include at least **[one]** **[two]** **<Insert number>** branch circuit port(s) for future use.
4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system.
5. Each branch circuit connection shall be fitted with an isolation valve and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.
 - a. If not available as an integral part of the heat recovery control unit, isolation valves shall be field installed adjacent to the unit pipe connection.

E. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: **<Insert sensor>**.
4. Features and Functions: Self-diagnostics, fuse protection, **<Insert function>**.
5. Communication: Network communication with indoor units and outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

F. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in **[metal]** raceways to comply with NFPA 70.

G. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.16 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units[, **HRCUs,**] and outdoor units shall include integral controls and connect through a **[TIA-485A]** **[or]** **[manufacturer-selected]** **<Insert network type>** control network.
2. Network Communication Protocol: **[Manufacturer proprietary]** **[or]** **[open]** control communication between interconnected units.
3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:
 - a. Ethernet connection via RJ-45 connectors and port with transmission at **[100]** **<Insert value>** Mbps or higher.

- b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least **[5 minutes]** **<Insert time>** of battery backup operation after a power loss.
 - c. Integration shall include **[control]** **[monitoring]** **[scheduling]** **[change of value notifications]** **<Insert requirements>**.
 - d. **<Insert requirements>**.
 - 4. Operator Interface:
 - a. Operators shall interface with system and unit controls through the following:
 - 1) Operator interfaces integral to controllers.
 - 2) Owner-furnished PC connected to central controller(s).
 - 3) Web interface through web browser software.
 - 4) Integration with Building Automation System.
 - b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:
 - 1) On/off control.
 - 2) Temperature set-point adjustment.
 - 3) **<Insert feature>**.
- B. VRF HVAC System Operator Software for PC:
 - 1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
 - 2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
 - 3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
 - 4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
 - 5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
 - 6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
 - 7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
 - 8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
 - 9. Supports Multiple Languages: **[English]** **[or]** **[French]** **[Spanish]** **<Insert language>**.
 - 10. Supports Imperial and Metric Temperature Units: **[Fahrenheit]** **[or]** **[Celsius]** **[Fahrenheit and Celsius]**.
 - 11. Displays service notifications and error codes.
 - 12. Monitors and displays up to **[3000]** **<Insert number>** item error history and **[10000]** **<Insert number>** item operation history for regular reporting and further archiving.
 - 13. Monitors and displays cumulative operating time of indoor units.
 - 14. Able to disable and enable operation of individual controllers for indoor units.
 - 15. Information displayed on individual controllers shall also be available for display.
 - 16. Information displayed for outdoor units, including refrigerant high and low pressures **[percent capacity]** **<Insert outdoor unit displays>**.
- C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.
 - a. Include multiple interconnected controllers as required.
2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
 - a. Sets schedule for daily, weekly, and annual events.
 - b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.
4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Information displayed for outdoor units, including refrigerant high and low pressures **[percent capacity] <Insert outdoor unit displays>**.
11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
12. Operator interface through a backlit, high-resolution color display touch panel **[and web accessible through standard web browser software]**.

D. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.
2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
3. Multiple Language: **[English] [or] [French] [Spanish] <Insert language>**.
4. Temperature Units: **[Fahrenheit] [or] [Celsius] [Fahrenheit and Celsius]**.
5. On/Off: Turns indoor unit on or off.
6. Hold: Hold operation settings until hold is released.
7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
8. Temperature Display: 1-degree increments.
9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between **<Insert temperature range>**.
10. Relative Humidity Display: 1 percent increments.
11. Relative Humidity Set-Point: Adjustable in 1 percent increments between **<Insert relative humidity range>**.
12. Fan Speed Setting: Select between available options furnished with the unit.
13. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
14. Seven-day programmable operating schedule with up to **[five] [eight] <Insert number>** events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
15. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
16. Occupancy detection.
17. Service Notification Display: "Filter" **<Insert notifications>**.
18. Service Run Tests: Limit use by service personnel to troubleshoot operation.

19. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
20. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
21. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
22. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.
23. **<Insert features and functions>.**

E. Wireless Controllers for Indoor Units:

1. Wireless Communication:
 - a. Controller communicates to remote-mounted receiver that is wired to indoor unit(s).
 - 1) Include receivers with wireless controllers as required to complete installation.
 - 2) Low-voltage power required for receivers shall be powered through non-polar connections to indoor unit.
 - b. One wireless controller shall be capable of communicating with one or multiple receivers to control one or multiple indoor units as a group.
2. Controller Battery Life: **[Three] <Insert number>** years.
3. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
4. Multiple Language: **[English] [or] [French] [Spanish] <Insert language>.**
5. Temperature Units: **[Fahrenheit] [or] [Celsius] [Fahrenheit and Celsius].**
6. On/Off: Turns indoor unit on or off.
7. Hold: Hold operation settings until hold is released.
8. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
9. Temperature Display: 1-degree increments.
10. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between **<Insert temperature range>.**
11. Relative Humidity Display: 1 percent increments.
12. Relative Humidity Set-Point: Adjustable in 1 percent increments between **<Insert relative humidity range>.**
13. Fan Speed Setting: Select between available options furnished with the unit.
14. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
15. Seven-day programmable operating schedule with up to **[five] [eight] <Insert number>** events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
16. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
17. Occupancy detection.
18. Service Notification Display: "Filter" **<Insert notifications>.**
19. Service Run Tests: Limit use by service personnel to troubleshoot operation.
20. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
21. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
22. Setting stored in non-volatile memory to ensure that settings are not lost if power is lost. Battery for date and time only.
23. **<Insert features and functions>.**

2.17 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

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1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
 2. ASHRAE 34, **[Class A1]** [or] **<Insert classification>** refrigerant classification.
 3. **[R-410a]** [or] **<Insert refrigerant>**.
- B. Oil:
1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.
- 2.18 SYSTEM CONDENSATE DRAIN PIPING
- A. If more than one material is listed, material selection is Contractor's option.
- B. Copper Tubing:
1. Drawn-Temper Tubing: According to **[ASTM B88, Type L (ASTM B88M, Type B)] [ASTM B88, Type M (ASTM B88M, Type C)]** or Type DWV according to ASTM B306.
 2. Wrought-Copper Fittings: ASME B16.22.
 3. Wrought-Copper Unions: ASME B16.22.
 4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux according to ASTM B813.
- C. CPVC plastic pipe according to ASTM F441/F441M, Schedule 40, with socket-type pipe fittings according to ASTM F438 and solvent cement according to ASTM F493.
- D. PVC plastic pipe according to ASTM D1785, Schedule 40, with socket-type pipe fittings according to ASTM D2466 and solvent cement according to ASTM D2564, primer according to ASTM F656.
- 2.19 SYSTEM HYDRONIC PIPING
- A. Comply with requirements in Section 232113 "Hydronic Piping" for system piping requirements.
- 2.20 SYSTEM REFRIGERANT PIPING
- A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.
- B. Refrigerant Piping:
1. Copper Tube: **[ASTM B280, Type ACR]** **<Insert material>**.
 2. Wrought-Copper Fittings: ASME B16.22.
 3. Brazing Filler Metals: AWS A5.8/A5.8M.
- C. Refrigerant Tubing Kits:
1. Furnished by VRF HVAC system manufacturer.
 2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
 3. Standard one-piece length for connecting to indoor units.
 4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
 5. Factory Charge: **[Dehydrated air or nitrogen]** [or] **<Insert charge>**.
- D. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.
- E. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
3. Valve Connections: Flare or sweat depending on size.

2.21 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of **[galvanized or copper-coated steel] [stainless steel] <Insert material>**.

B. Plastic Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, galvanized-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of **[galvanized steel] [stainless steel] <Insert material>**.

2.22 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Cooper B-line; brand of Eaton, Electrical Sector.
 - c. Flex-Strut Inc.
 - d. G-Strut.
 - e. Haydon Corporation.
 - f. MIRO Industries.
 - g. Unistrut; Atkore International.
 - h. Wesanco, Inc.
 - i. **<Insert manufacturer's name>**.
2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
4. Channels: Continuous slotted **[carbon-steel] [stainless steel, Type 304] [stainless steel, Type 316] [extruded-aluminum] <Insert material>** channel with inturned lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of **[galvanized steel] <Insert material>** for use indoors and of **[stainless steel] <Insert material>** for use outdoors.
8. Metallic Coating for Use Indoors: **[No coating] [Electroplated zinc] [Hot-dip galvanized] [Gold (yellow zinc dichromate) galvanized]**.
9. Plastic Coating for Use Outdoors: **[PVC] <Insert plastic type>**.

2.23 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded, zinc-coated 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.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Indoor Applications: **[Zinc-coated] [or] [stainless]** steel.
 - 2. Outdoor Applications: Stainless steel.

2.24 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIRO Industries.
 - b. PHP Systems/Design.
 - c. RectorSeal HVAC; a CSW Industrials Company.
 - d. Rooftop Support Systems; Eberl Iron Works, Inc.
 - e. **<Insert manufacturer's name>.**
 - 2. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 3. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - a. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.
 - 4. Hardware: Galvanized steel or polycarbonate.
 - 5. Accessories: Protection pads.
- C. Low-Profile, Single-Base, Single-Pipe Stand:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIRO Industries.
 - b. PHP Systems/Design.
 - c. Rooftop Support Systems; Eberl Iron Works, Inc.
 - d. **<Insert manufacturer's name>.**
 - 2. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
 - 3. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - a. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.
 - 4. Vertical Members: Two, **[galvanized] [stainless]**-steel, continuous-thread 1/2-inch (12-mm) rods.
 - 5. Horizontal Member: Adjustable horizontal, **[galvanized-steel] [stainless steel]** pipe support channels.
 - 6. Pipe Supports: **[Roller] [Strut clamps] [Clevis hanger] [Swivel hanger]**.

7. Hardware: **[Galvanized] [Stainless]** steel.
 8. Accessories: Protection pads.
 9. Height: **[12 inches (300 mm) above roof] <Insert lesser dimension above roof>**.
- D. High-Profile, Single-Base, Single-Pipe Stand:
1. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. MIRO Industries.
 - b. PHP Systems/Design.
 - c. Rooftop Support Systems; Eberl Iron Works, Inc.
 - d. **<Insert manufacturer's name>**.
 2. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 3. Base: Single vulcanized rubber or molded polypropylene.
 - a. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.
 4. Vertical Members: Two, **[galvanized-steel] [stainless steel]**, continuous-thread 1/2-inch (12-mm) rods.
 5. Horizontal Member: One, adjustable height, **[galvanized-steel] [or] [stainless steel]** pipe support slotted channel or plate.
 6. Pipe Supports: **[Roller] [Clevis hanger] [Swivel hanger]**.
 7. Hardware: **[Galvanized] [Stainless]** steel.
 8. Accessories: Protection pads[, **1/2-inch (12-mm) continuous-thread galvanized-steel rod] [, 1/2-inch (12-mm) continuous-thread stainless steel rod]**.
 9. Height: **[36 inches (900 mm) above roof] <Insert lesser dimension above roof>**.
- E. High-Profile, Multiple-Pipe Stand:
1. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. MIRO Industries.
 - b. PHP Systems/Design.
 - c. RectorSeal HVAC; a CSW Industrials Company.
 - d. Rooftop Support Systems; Eberl Iron Works, Inc.
 - e. **<Insert manufacturer's name>**.
 2. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 3. Bases: Two or more; **[vulcanized rubber] [molded polypropylene] <Insert material>**.
 - a. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.
 4. Vertical Members: Two or more, **[galvanized-steel] [stainless steel]** channels.
 5. Horizontal Members: One or more, adjustable height, **[galvanized-steel] [stainless steel]** pipe support.
 6. Pipe Supports: **[Roller] [Strut clamps] [Clevis hanger] [Swivel hanger]**.
 7. Hardware: **[Galvanized] [Stainless]** steel.
 8. Accessories: Protection pads[, **1/2-inch (12-mm) continuous-thread rod]**.
 9. Height: **[36 inches (900 mm) above roof] <Insert lesser dimension above roof>**.

- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.25 OUTDOOR EQUIPMENT STANDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. MIRO Industries.
 - 2. RectorSeal HVAC; a CSW Industrials Company.
 - 3. Rooftop Support Systems; Eberl Iron Works, Inc.
 - 4. **<Insert manufacturer's name>.**
- B. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof-supported outdoor equipment components, without roof membrane penetration, in a prefabricated system that can be modularly assembled on-site.
- C. Foot Material: Rubber or polypropylene.
- D. Rails Material: Hot-dip galvanized carbon steel.
- E. Wind/Sliding Load Resistance: Up to **[100 mph (44 m/s)] <Insert value>** minimum.

2.26 MISCELLANEOUS SUPPORT MATERIALS

- A. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.
- C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

2.27 PIPING AND TUBING INSULATION

- A. Comply with requirements in Section 230719 "HVAC Piping Insulation" for system piping insulation requirements.
- B. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:
 - 1. Flexible Elastomeric Insulation:
 - a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
 - b. Indoors: **[1/2 inch (13 mm)] [3/4 inch (19 mm)] [1 inch (25 mm)] <Insert dimension>** thick.
 - c. Outdoors: **[1/2 inch (13 mm)] [3/4 inch (19 mm)] [1 inch (25 mm)] <Insert dimension>** thick.
 - 2. Field-Applied Jacket:
 - a. Concealed: None required.
 - b. Indoors, Exposed to View: **[None required] [PVC, 20 mils (0.5 mm) thick] [PVC, color selected by Architect, 20 mils (0.5 mm) thick] <Insert jacket>.**
 - c. Outdoors, Exposed to View: **[None required] [Aluminum, smooth, 0.020 inch (0.51 mm) thick] <Insert jacket>.**

C. Refrigerant Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

- a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
- b. Indoors: **[1 inch (25 mm)] <Insert dimension> thick.**
- c. Outdoors: **[1 inch (25 mm)] <Insert dimension> thick.**

2. Field-Applied Jacket:

- a. Concealed: None required.
- b. Indoors, Exposed to View: **[None required] [PVC, 20 mils (0.5 mm) thick] [PVC, color selected by Architect, 20 mils (0.5 mm) thick] <Insert jacket>.**
- c. Outdoors, Exposed to View: **[None required] [Aluminum, smooth, 0.020 inch (0.51 mm) thick] <Insert jacket>.**

D. Flexible Elastomeric Insulation Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

F. Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

5. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.28 SYSTEM CONTROL CABLE

- A. Cable Rating: Listed and labeled for application according to NFPA 70.
 1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - a. Flame Travel Distance: 60 inches (1520 mm) or less.
 - b. Peak Optical Smoke Density: 0.5 or less.
 - c. Average Optical Smoke Density: 0.15 or less.
 2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
 3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- B. Low-Voltage Control Cabling:
 1. Paired Cable: NFPA 70, Type CMG.
 - a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
 - b. PVC insulation.
 - c. Braided or foil shielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1685.
 2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 - a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
 - b. PVC insulation.
 - c. Braided or foil shielded.
 - d. PVC jacket.
 - e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
 - f. Flame Resistance: Comply with NFPA 262.
 3. Lead Content: Less than 300 parts per million.

- C. TIA-485A Network Cabling:
 - 1. Standard Cable: NFPA 70, Type CMG.
 - a. Paired, **[one pair] [two pairs]**, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1685.
 - 2. Plenum-Rated Cable: NFPA 70, Type CMP.
 - a. Paired, **[one pair] [two pairs]**, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - b. Fluorinated ethylene propylene insulation.
 - c. Unshielded.
 - d. Fluorinated ethylene propylene jacket.
 - e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
 - f. Flame Resistance: NFPA 262.
- D. Ethernet Network Cabling: TIA-568-C.2 Category **[6] [6a] <Insert category>** cable with **[RJ-45] <Insert connector type>** connectors.
 - 1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.
 - 2. Conductors: 100-ohm, 23 AWG solid copper.
 - 3. Shielding: **[Unshielded twisted pairs (UTP)] [Shielded twisted pairs (FTP)]**.
 - 4. Cable Rating: By application.
 - 5. Jacket: **[White] [Gray] [Blue] [Yellow] <Insert color>** thermoplastic.
- E. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for cable raceways.

2.29 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.
- E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
- F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a **[3000] <Insert time>**-hour salt-spray test according to ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
 - c. ASTM B3359 for cross-hatch adhesion of 5B.

2. Application: **[Immersion] [Spray]**.
3. Thickness: **[1 mil (0.025 mm)] <Insert value>**.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.30 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect factory-assembled equipment.
- B. Equipment will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION – NOT USED

END OF SECTION 238129

SECTION 238219 - FAN COIL UNITS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Vibration, Seismic and Wind Loading Performance: Withstand the effects of vibration, seismic and wind loading forces determined by Division 23 Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Sustainable Design Requirements: Provide products in accordance with the requirements as specified in Section 018113 "Sustainable Design Requirements" for the following:
 - 1. Recycled content.
 - 2. Adhesives: VOC content and emissions evaluation.
 - 3. Paints and Coatings: VOC content and emissions evaluation.
 - 4. Chemical content.

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.
- C. For units with outdoor installation, preference is to run piping high on roof to provide walking clearance and minimize pipe cladding destruction(elevated).
- D. Include Economizer mode for all fan coils if available by type.
- E. Provide a sensor that detects pressure in the buliding(in wc.) in order to prevent over pressurization if fan coils units are the primary means of ventilating.

2.3 DUCTLESS FAN COIL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airtherm; a Mestek company.
 - 2. Carrier Corporation; a unit of United Technologies Corp.
 - 3. DRS Marlo Coil; part of DRS Technologies, Inc.
 - 4. Dunham-Bush.
 - 5. Engineered Air.
 - 6. ENVIRO-TEC; by Johnson Controls, Inc.
 - 7. First Company Products.
 - 8. Greenheck Fan Corporation.
 - 9. IEC (International Environmental Corporation); LSB Industries.
 - 10. Nailor Industries Inc.
 - 11. Rosemex Products.
 - 12. Superior Rex.
 - 13. Titus.
 - 14. Trane Inc.
 - 15. USA Coil & Air.
 - 16. YORK; a Johnson Controls company.
 - 17. McQuay International.
- B. Fan Coil Unit Configurations: As indicated on drawings.

- C. Coil Section Insulation: **[1/2-inch- (13-mm-)] [1-inch- (25-mm-)] <Insert dimension>** thick, **[coated glass fiber] [foil-covered, closed-cell foam] [matte-finish, closed-cell foam]** complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Coil Section Insulation: Insulate coil section according to Section 230616 "HVAC Equipment Insulation."
1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- E. **[Main and Auxiliary]**Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.**[Drain pans shall be removable.]**
- F. Chassis: Galvanized steel where exposed to moisture**[, with baked-enamel finish and removable access panel][, with powder-coat finish and removable access panel]**. Floor-mounting units shall have leveling screws.
- G. Cabinet: Steel with **[factory prime coating, ready for field painting] [baked-enamel finish in manufacturer's standard paint color as selected by Architect] [baked-enamel finish in manufacturer's custom paint color as selected by Architect]**.
1. Vertical Unit Front Panels: Removable, steel, with **[integral stamped] [polyethylene] [steel]** discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
 2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with **[integral stamped] [cast-aluminum]** discharge grilles.
 3. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from manufacturer's custom colors. Return grille shall provide maintenance access to fan coil unit.
 4. Steel recessing flanges for recessing fan coil units into ceiling or wall.
- H. Outdoor-Air Wall Box: Minimum 0.1265-inch- (3.2-mm-) thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.
1. Louver Configuration: **[Horizontal] [Vertical]**, rain-resistant louver.
 2. Louver Material: **[Aluminum] [Steel]**.
 3. Bird Screen: 1/2-inch (13-mm) mesh screen on interior side of louver.
 4. Decorative Grille: On outside of intake.
 5. Finish: **[Anodized aluminum] [Baked enamel]**, color as selected by Architect from manufacturer's custom colors.
- I. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with **[electronic] [pneumatic], [two-position] [modulating]** actuators.
- J. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
1. MERV Rating: **[6] [13] <Insert number>** when tested according to ASHRAE 52.2.
 2. Washable Foam: 70 percent arrestance and MERV 3.
 3. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.
 4. Pleated Cotton-Polyester Media: 90 percent arrestance and MERV 7.

- K. Hydronic Coils: Copper tube[**with corrosion-resistant coating**], with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
- L. Corrosion-Resistant Coating: Coat coils with a corrosion-resistant coating capable of withstanding a 3,000-hour salt-spray test according to ASTM B 117.
 - 1. Standards:
 - a. ASTM B 117 for salt spray.
 - b. ASTM D 2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
 - c. ASTM D 3359 for cross hatch adhesion of 5B.
 - 2. Application: **[Immersion] [Spray]**.
 - 3. Thickness: 1 mil.
 - 4. Gloss: Minimum gloss of 50 gloss units on a single angle 60 degree meter.
 - 5. UV Protection: Spray applied topcoat.
- M. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware. Provide thermally operated linear limit switch with capillary tube extending across the entire width of the electric coil area. Provide secondary safety protection using a fusible link cutoff device in the power lines of each coil. Provide control panel containing contactors, transformer, door interlocking disconnect switch, air flow switch, manual and automatic high limit switches, stage control, automatic changeover and relay.
- N. Fan and Motor Board: Removable.
 - 1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 - 2. Motor: "ECM" Motor shall be provided. Permanently lubricated, multispeed; resiliently mounted on motor board. Factory calibrated FPB for optimum unit efficiency for operating CFM per schedule on drawing. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 3. Wiring Termination: Connect motor to chassis wiring with plug connection.
- O. Factory, Hydronic Piping Package: ASTM B 88, Type L (ASTM B 88M, Type B) copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
 - 1. **[Two][Three]-way, [two-position] [modulating]** control valve for dual-temperature coil.
 - 2. **[Two][Three]-way, [two-position] [modulating]** control valve for chilled-water coil.
 - 3. **[Two][Three]-way, [two-position] [modulating]** control valve for hot-water heating coil.
 - 4. **[Two][Three]-way [two-position] [modulating]** control valve for hot-water reheat coil.
 - 5. Hose Kits: Minimum 400-psig (2758-kPa) working pressure and operating temperatures from 33 to 211 deg F (0.5 to 99 deg C). Tag hose kits to equipment designations.
 - a. Length: **[24 inches (600 mm)] [36 inches (900 mm)] <Insert dimension>**.
 - b. Minimum Diameter: Equal to fan coil unit connection size.
 - 6. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.
 - 7. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.

8. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig (2070-kPa) working pressure at 250 deg F (121 deg C); with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig (13.8 to 552 kPa).
 9. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig (860-kPa) working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) hose-end, full-port, ball-type blowdown valve in drain connection.
 10. Wrought-Copper Unions: ASME B16.22.
 11. Risers: **[ASTM B 88, Type L (ASTM B 88M, Type B)] [ASTM B 88, Type M (ASTM B 88M Type C)]** copper pipe with hose and ball valve for system flushing.
- P. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC".
- Q. Basic Unit Controls:
1. Control voltage transformer.
 2. **[Wall-mounting] [Unit-mounted]** thermostat with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. **[Manual] [Automatic]** changeover.
 - e. Adjustable deadband.
 - f. **[Concealed] [Exposed]** set point.
 - g. **[Concealed] [Exposed]** indication.
 - h. **[Degree F] [Degree C]** indication.
 3. **[Wall-mounting] [Unit-mounted]** humidistat.
 - a. **[Concealed] [Exposed]** set point.
 - b. **[Concealed] [Exposed]** indication.
 4. **[Wall-mounting] [Unit-mounted]** temperature sensor.
 5. Unoccupied-period-override push button.
 6. Data entry and access port.
 - a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
 - b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.
- R. **[DDC]** Terminal Controller:
1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
 2. Unoccupied-Period-Override Operation: **[Two] <Insert number>** hours.
 3. Unit Supply-Air Fan Operation:
 - a. Occupied Periods: Fan runs continuously.
 - b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
 4. Hydronic-Cooling-Coil Operation:
 - a. Occupied Periods: **[Open] [Modulate]** control valve to maintain room temperature.
 - b. Unoccupied Periods: Close control valve.

5. Refrigerant-Coil Operation:
 - a. Occupied Periods: Start compressor to maintain room temperature or humidistat set point.
 - b. Unoccupied Periods: Stop compressor cooling and cycle compressor for heating to maintain setback temperature.
6. **[Supplemental]**Heating-Coil Operation:
 - a. Occupied Periods: **[Open control valve] [Modulate control valve] [Energize electric-resistance coil]** to provide heating if room temperature falls below thermostat set point.
 - b. Unoccupied Periods: Start fan and **[open control valve] [modulate control valve] [energize electric-resistance coil]** if room temperature falls below setback temperature.
 - c. Switch refrigerant-reversing valve to operate supplemental coil for heating when outdoor temperature is below **[25 deg F (4 deg C)] <Insert temperature>**.
7. Dual-Temperature Hydronic-Coil Operation:
 - a. Occupied Periods: When chilled water is available, **[open] [modulate]** control valve if room temperature exceeds thermostat set point. When hot water is available, open control valve if temperature falls below thermostat set point.
 - b. Unoccupied Periods: When chilled water is available, close control valve. When hot water is available, **[open] [modulate]** control valve if room temperature falls below thermostat setback temperature.
8. Reheat-Coil Operation:
 - a. Humidity Control for Occupied Periods:
 - 1) Humidistat **[opens control valve] [modulates control valve] [energizes electric-resistance coil]** to provide heating. As space temperature rises above set point, cooling-coil valve **[opens] [modulates]** to maintain room temperature.
 - b. Humidity Control for Unoccupied Periods: **[Close control valve] [De-energize]**.
 - c. Occupied Periods:
 - 1) Heating Operations: **[Open control valve] [Modulate control valve] [Energize electric-resistance coil]** to provide heating if room temperature falls below thermostat set point.
 - 2) Humidity-Control Operations: Humidistat **[opens control valve] [modulates control valve] [energizes electric-resistance coil]** to provide heating. As space temperature rises above set point, cooling-coil valve **[opens] [modulates]** to maintain room temperature.
 - d. Unoccupied Periods: Start fan and **[open control valve] [modulate control valve] [energize electric-resistance coil]** if room temperature falls below setback temperature. Humidity control is not available.
9. Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open damper to fixed position for **[25] <Insert number>** percent outdoor air.
 - b. Unoccupied periods: Close damper.

10. Outdoor-Air Damper Operation:

a. Occupied Periods:

- 1) Outdoor-Air Temperature below Room Temperature: If room temperature is above thermostat set point, modulate outdoor-air damper to maintain room temperature (outdoor-air economizer). If room temperature is below thermostat set point, position damper to fixed minimum position.
- 2) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for [25] <Insert number> percent outdoor air.

b. Unoccupied Periods: Close damper.

11. Outdoor-Air Damper Operation (Enthalpy Based):

a. Occupied Periods:

- 1) Outdoor-Air Enthalpy below Room Enthalpy: If room temperature is above room-temperature set point, modulate outdoor-air damper to maintain room temperature (outdoor-air economizer). If room temperature is below set point, position damper to fixed minimum position for [25] <Insert number> percent outdoor air.
- 2) Outdoor-Air Enthalpy above Room Enthalpy: Position damper to fixed minimum position for [25] <Insert number> percent outdoor air.

b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

12. Controller shall have volatile-memory backup.

S. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide [BACnet] [or] [LonWorks] interface for central DDC system for HVAC workstation for the following functions:
 - a. Adjust set points.
 - b. Fan coil unit start, stop, and operating status.
 - c. Data inquiry, including [outdoor-air damper position,]supply- and room-air temperature[and humidity].
 - d. Occupied and unoccupied schedules.

T. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.4 DUCTED FAN COIL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; a unit of United Technologies Corp.
2. DRS Marlo Coil; part of DRS Technologies, Inc.
3. Dunham-Bush.
4. Engineered Air.
5. ENVIRO-TEC; by Johnson Controls, Inc.
6. First Company Products.
7. Greenheck Fan Corporation.
8. IEC (International Environmental Corporation); LSB Industries.
9. Nailor Industries Inc.
10. Rosemex Products.
11. Superior Rex.

12. Titus.
 13. Trane Inc.
 14. USA Coil & Air.
 15. Williams Comfort Products.
 16. YORK; a Johnson Controls company.
 17. McQuay International
- B. Fan Coil Unit Configurations: As indicated on drawings.
- C. Coil Section Insulation: **[1/2-inch- (13-mm-)] [1-inch- (25-mm-)] <Insert dimension>** thick, **[coated] [foil-faced]** glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Coil Section Insulation: Insulate coil section according to Section 230616 "HVAC Equipment Insulation."
1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- E. **[Main and Auxiliary]**Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- F. Chassis: Galvanized steel where exposed to moisture**[, with baked-enamel finish and removable access panel][, with powder-coat finish and removable access panel]**. Floor-mounting units shall have leveling screws.
- G. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis**[with mill-finish, aluminum, double-deflection grille]**.
 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
 3. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
 4. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- H. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
- I. MERV Rating: **[6] [13] <Insert number>** when tested according to ASHRAE 52.2.
1. Washable Foam: 70 percent arrestance and MERV 3.
 2. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.
 3. Pleated Cotton-Polyester Media: 90 percent arrestance and MERV 7.
- J. Hydronic Coils: Copper tube**[with corrosion-resistant coating]**, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain.

- K. Corrosion-Resistant Coating: Coat **[coils]** **[and]** **[fan guards]** with a corrosion-resistant coating capable of withstanding a 3,000-hour salt-spray test according to ASTM B 117.
1. Standards:
 - a. ASTM B 117 for salt spray.
 - b. ASTM D 2794 for minimum impact resistance of 100 in-lb (11.3 N-m)
 - c. ASTM D-3359 for cross hatch adhesion of 5B.
 2. Application: Spray.
 3. Thickness: 1 mil.
 4. Gloss: Minimum gloss of 50 gloss units on a single angle 60 degree meter.
 5. UV Protection: Spray applied topcoat.
- L. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware. Provide thermally operated linear limit switch with capillary tube extending across the entire width of the electric coil area. Provide secondary safety protection using a fusible link cutoff device in the power lines of each coil. Provide control panel containing contactors, transformer, door interlocking disconnect switch, air flow switch, manual and automatic high limit switches, stage control, automatic changeover and relay.
- M. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
1. Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
- N. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
1. Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
- O. Factory, Hydronic Piping Package: ASTM B 88, Type L (ASTM B 88M, Type B) copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
1. **[Two][Three]-way, [two-position] [modulating]** control valve for chilled-water coil.
 2. **[Two][Three]-way, [two-position] [modulating]** control valve for heating coil.
 3. **[Two][Three]-way, [two-position] [modulating]** control valve for dual-temperature coil.
 4. **[Two][Three]-way, [two-position] [modulating]** control valve for reheat coil.
 5. Hose Kits: Minimum 400-psig (2758-kPa) working pressure and operating temperatures from 33 to 211 deg F (0.5 to 99 deg C). Tag hose kits to equipment designations.
 - a. Length: **[24 inches (600 mm)] [36 inches (900 mm)] <Insert dimension>**.
 - b. Minimum Diameter: Equal to fan coil unit connection size.
 6. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.
 7. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.

8. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig (2070-kPa) working pressure at 250 deg F (121 deg C); with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig (13.8 to 552 kPa).
 9. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig (860-kPa) working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) hose-end, full-port, ball-type blowdown valve in drain connection.
 10. Wrought-Copper Unions: ASME B16.22.
- P. Remote condensing units are specified in Section 236200 "Packaged Compressor and Condenser Units."
- Q. Basic Unit Controls:
1. Control voltage transformer.
 2. **[Wall-mounting] [Unit-mounted]** thermostat with the following features.
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. **[Manual] [Automatic]** changeover.
 - e. Adjustable deadband.
 - f. **[Concealed] [Exposed]** set point.
 - g. **[Concealed] [Exposed]** indication.
 - h. **[Degree F] [Degree C]** indication.
 3. **[Wall-mounting] [Unit-mounted]** humidistat.
 - a. **[Concealed] [Exposed]** set point.
 - b. **[Concealed] [Exposed]** indication.
 4. **[Wall-mounting] [Unit-mounted]** temperature sensor.
 5. Unoccupied-period-override push button.
 6. Data entry and access port.
 - a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
 - b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.
- R. **[DDC]** Terminal Controller:
1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
 2. Unoccupied-Period-Override Operation: Two hours.
 3. Unit Supply-Air Fan Operation:
 - a. Occupied Periods: Fan runs continuously.
 - b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
 4. Hydronic-Cooling-Coil Operation:
 - a. Occupied Periods: **[Open] [Modulate]** control valve to maintain room temperature.
 - b. Unoccupied Periods: Close control valve.
 5. Refrigerant-Coil Operation:
 - a. Occupied Periods: Start compressor to maintain room temperature or humidistat set point.

- b. Unoccupied Periods: Stop compressor cooling and cycle compressor for heating to maintain setback temperature.
6. **[Supplemental]Heating-Coil Operation:**
- a. Occupied Periods: **[Open control valve] [Modulate control valve] [Energize electric-resistance coil]** to provide heating if room temperature falls below thermostat set point.
 - b. Unoccupied Periods: Start fan and **[open control valve] [modulate control valve] [energize electric-resistance coil]** if room temperature falls below setback temperature.
 - c. Switch refrigerant-reversing valve to operate supplemental coil for heating when outdoor temperature is below **[25 deg F (4 deg C)] <Insert temperature>**.
7. **Dual-Temperature Hydronic-Coil Operation:**
- a. Occupied Periods: When chilled water is available, **[open] [modulate]** control valve if room temperature exceeds thermostat set point. When hot water is available, **[open] [modulate]** control valve if temperature falls below thermostat set point.
 - b. Unoccupied Periods: When chilled water is available, close valve. When hot water is available, **[open] [modulate]** control valve if room temperature falls below thermostat setback temperature.
8. **Reheat-Coil Operation:**
- a. Humidity Control for Occupied Periods:
 - 1) Humidistat **[opens control valve] [modulates control valve] [energizes electric-resistance coil]** to provide heating. As room temperature rises above set point, cooling-coil valve **[opens] [modulates]** to maintain room temperature.
 - b. Humidity Control for Unoccupied Periods: **[Close control valve] [De-energize]**.
 - c. Occupied Periods:
 - 1) Heating Operations: **[Open control valve] [Modulate control valve] [Energize electric-resistance coil]** to provide heating if room temperature falls below thermostat set point.
 - 2) Humidity-Control Operations: Humidistat **[opens control valve] [modulates control valve] [energizes electric-resistance coil]** to provide heating. As room temperature rises above set point, cooling-coil valve **[opens] [modulates]** to maintain room temperature.
 - d. Unoccupied Periods: Start fan and **[open control valve] [modulate control valve] [energize electric-resistance coil]** if room temperature falls below setback temperature. Humidity control is not available.
9. **Outdoor-Air Damper Operation:**
- a. Occupied Periods: Open damper to fixed position for **[25] <Insert number>** percent outdoor air.
 - b. Unoccupied Periods: Close damper.

10. Outdoor-Air Damper Operation:
 - a. Occupied Periods:
 - 1) Outdoor-Air Temperature below Room Temperature: If room temperature is above room-temperature set point, modulate outdoor- and return-air dampers to maintain room temperature set point (outdoor-air economizer). If room temperature is below set point, position damper to fixed minimum setting.
 - 2) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for 25 percent outdoor air.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
 11. Outdoor-Air Damper Operation (Enthalpy Based):
 - a. Occupied Periods:
 - 1) Outdoor-Air Enthalpy below Room Enthalpy: If room temperature is above room-temperature set point, modulate outdoor-air damper to maintain room temperature (outdoor-air economizer). If room temperature is below set point, position damper to fixed minimum position for 25 percent outdoor air.
 - 2) Outdoor-Air Enthalpy above Room Enthalpy: Position damper to fixed minimum position for 25 percent outdoor air.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
 12. Controller shall have volatile-memory backup.
- S. Interface with DDC System for HVAC Requirements:
1. Interface relay for scheduled operation.
 2. Interface relay to provide indication of fault at the central workstation.
 3. Provide BACnet interface for central DDC system for HVAC workstation for the following functions:
 - a. Adjust set points.
 - b. Fan coil unit start, stop, and operating status.
 - c. Data inquiry, including [**outdoor-air damper position**,]supply- and room-air temperature[**and humidity**].
 - d. Occupied and unoccupied schedules.
- T. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION – NOT USED

END OF SECTION 238219

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SECTION 250550 - INTEGRATED FACILITY PERFORMANCE DASHBOARD DISPLAYS

PART 1 - PRODUCTS

1.1 REGULATORY REQUIREMENTS

- A. Listing and Labeling: Provide components that are listed and labeled for the application.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code Article 100.
- B. Electrical Component Standard: Components and installations shall comply with NFPA 70, "National Electrical Code."
- C. NEMA Standard: Comply with NEMA Standards for applicable component installations within various distribution equipment.
- D. ANSI/IEEE Compliance: Comply with applicable requirements of ANSI/IEEE Standard C2, "National Electrical Safety Code."
- E. ANSI C37 90.1 Specific Compliance: Comply with surge withstand and high speed transient voltage requirements for electronic equipment.
- F. 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.

1.2 FACILITY PERFORMANCE DASHBOARD DISPLAYS

- A. **[Two (2)]** flat screen LCD displays.
- B. Minimum **[42] [46] [52]** inch diagonal LCD flat panel HDTV color monitor with:
 - 1. HD 1080p resolution.
 - 2. 120 Hz motion flow.
 - 3. Built-in speakers.
 - 4. **[Touch screen software interaction.]**
 - 5. Connectivity:
 - a. Four HDMI connection ports.
 - b. Digital media port.
 - c. VGA input port.
 - 6. Remote control unit.
 - 7. Energy Star compliant.
 - 8. Black finish.
 - 9. Wall mount **[pivot type] [kiosk mounted]** bracket.
 - 10. Wall plate with matching connector cables to associated PC.
 - 11. VGA amplifier with balanced audio and cabling from PC location.
 - 12. Manufacturers:
 - a. Horizon.
 - b. Sony.
 - c. LG.
 - d. NEC.
 - e. ELO.

- C. Customized professionally produced display software from CD loaded PC shall selectivity present in timed rotating displays:
 - 1. LCD Display 1 – Introduction by Owner’s representative outlining key for:
 - a. Project information.
 - b. Owner information.
 - c. A/E information.
 - d. Contractor information.
 - e. Facilities Management information.
 - f. Energy benchmark comparisons (i.e., Energy Star).
 - g. Sustainable benchmark comparisons (i.e., LEED).
 - 2. LCD Display 1 – Facility sustainable design and high performance building elements:
 - a. Building envelope.
 - b. Chilled Beam.
 - c. Daylighting.
 - d. Solar Heating.
 - e. Water Consumption.
 - 3. LCD Display 1 – Facility integrated technologies.
 - 4. LCD Display 1 – Construction time-lapsed video.
 - 5. LCD Display 2 – Facility energy use metrics:
 - a. Real-time energy usage with Energy Star benchmarks.
 - b. Yearly trending graphic with Energy Star benchmarks.
 - 6. Customized Software Providers:
 - a. Agilewaves.
 - b. Lucid Design Group.
 - c. Quality Automation Graphics.
 - d. Small Energy group.

1.3 PERSONAL COMPUTER WORKSTATIONS

- A. By Owner.

1.4 METERING AND MONITORING SOFTWARE

- A. Capable of operating in a multiuser multi-tasking environment using the latest version of Microsoft Windows.
- B. Password Protection: Three minimum configurable security levels.
- C. On-Line Help: Context sensitive.
- D. Coordinates the communications of the network.
- E. Provides interactive color graphics platform with mouse accessed menu and mouse driven generation of system graphics.
- F. Provides mouse driven interface with devices depicted in single-line diagram and equipment elevation screens.
- G. Provides time programmable display sleep mode for energy savings.
- H. Exports and imports data to and from commonly used Microsoft Windows Excel spreadsheet, database, tenant billing, and other applications; uses dynamic data exchange technology.

- I. Reports Trends: Instantaneously, in a real-time or historical tabular format, bar chart, or user-defined time, trend plots of monitored parameters; unlimited as to interval, duration, or quantity of trends.
- J. Communicates with BAS main workstation PC or server.
- K. Communicates with Electric Power Management mechanical workstation PC or server.

1.5 COMMUNICATION COMPONENTS AND NETWORK REQUIREMENTS

- A. Network Configuration: High speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet and **[Modbus]** **[BACnet]** **[LonWorks]** TCP/IP protocol.

1.6 LOW-VOLTAGE WIRING

- A. Data Line Cable: Shielded, twisted-pair cable or other media recommended by manufacturer and as specified in Division 27 Section "Structured Telecommunication Cabling Systems."
- B. LAN RS-485 Cables: Comply with Division 27 Section "Structured Telecommunication Cabling Systems."
 - 1. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs twisted, No. 22 AWG, stranded (7 x 30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
 - 2. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7 x 30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.
 - 3. Unshielded Twisted Pair Cables: Category **[5e]** **[6]** as specified for horizontal cable for data service in Division 27 Section "Structured Telecommunications Cabling Systems."
- C. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
 - 1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
 - 2. Ordinary Switching Circuits: Three conductors, unless otherwise indicated.
 - 3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

1.7 ACCESSORIES

- A. Interfaces with Distribution Equipment Specified in Other Sections: Accessories, adapters, electronic interface units, and connections required for functional performance indicated.

END OF SECTION 250550

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SECTION 255105 - INTEGRATED FACILITY CONTROL SYSTEM (IFCS)

PART 1 - PRODUCTS

1.1 ACCEPTABLE MANUFACTURERS AND INSTALLERS

- A. Manufacturers: Subject to compliance with requirements, provide Integrated Facility Control System by one of the following:
 - 1. Alerton Controls (TP Woodside).
 - 2. Andover Controls (U&S Services).
 - 3. Honeywell.
 - 4. Invensys (BCS).
 - 5. Johnson Controls.
 - 6. Siemens Building Technologies.
 - 7. Trane (Gerster Trane).
- B. Installers: An authorized factory representative or a branch office of an acceptable manufacturer shall install the IFCS.

1.2 REGULATORY REQUIREMENTS

- A. Codes and Standards:
 - 1. UL Compliance: Provide electrical components of Division 25 control systems which have been UL-listed and labeled, and comply with NEMA standards. Provide control devices, which are UL listed as a signal appliance.
 - 2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for Division 25 control systems.
 - 3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
- B. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- C. Division 25 systems shall comply with UL 916 PAZX and be so listed.

1.3 OPEN PROTOCOL DESIGN CRITERIA

- A. This project shall comprise a building-wide network utilizing Open Standard protocols over the ISO 8802-3 (Ethernet) infrastructure for the purposes of integrating individual systems. Wherever possible, the global ISO 16484-5 standard (ASHRAE Standard 135-2001-BACnet) shall be used to connect the Integrated Facility Control System with HVAC Controls, Laboratory Airflow Control System, Access Control/Intrusion Detection, Closed Circuit TV Systems, and the Fire Alarm System.
- B. Workstation information access shall use the BACnet Protocol. Communication shall use Annex J of ASHRAE Standard 135-2001 (ISO 16484-5). Local connections of the workstation shall be on ISO 8802-3 (Ethernet). Remote communications all use either the BACnet Point to Point Physical/Data Link Layer Protocol or IP over Point to point (PTP).
- C. Each Building Controller shall reside on the Enterprise wide network, which is same high-speed network as the workstations. The Enterprise wide network shall support the Internet Protocol (IP). Local connections of the Building Controller shall be on ISO 8802-3 (Ethernet). Communications shall use Annex J of ASHRAE Standard 135-2001. Each Building Controller shall also perform routing to a network of Custom Application and Application Specific Controllers.

- D. Wherever possible, the sub-network for the HVAC Control System shall be comprised of devices connected via twisted wired pair using the EIA 709.1 standard (LonTalk) communications protocol. This protocol shall be used for communications between Building Controllers to a network of Custom Application Controllers and Application Specific Controllers using LonTalk FTT-10 and LonMark profiles.
- E. The industrial defacto standard of Modbus RTU, over a 2-wire EIA 485 connections shall be used for[, **but not limited to**,] interfaces to boilers, variable frequency drives, fume hood controls, etc. and whenever the open standard protocols BACnet and LonTalk are not widely available.

1.4 IFCS ARCHITECTURE

- A. The IFCS shall be capable of monitoring and controlling up to 10,000 Controllers, each connected in real-time through the Owner's network back to one central monitoring station. A dial-up telephone connection shall also be utilized.
- B. Network controllers shall have native, direct Ethernet TCP/IP communications back to a central monitoring station, using the customer's existing installed network. A 10bT Ethernet port shall be provided on the controller for this communications interface. All TCP/IP settings, including IP address, default gateway and subnet mask, shall be stored in non-volatile memory.
- C. Network controllers shall include a built-in web server, such that all point values may be viewed and controller from a standard browser environment. Custom web pages, password-protected, shall be able to be stored within the network controller for access by technicians for troubleshooting and maintenance.
- D. Network controllers shall provide at least four (4) serial communications ports. One port shall be configured as a dial-up modem for back-up communications to the network controller in case the main network connection is unavailable. The remaining ports may be used to connect to Division 27 subsystems.
- E. Network controller shall accept 120VAC power. The power supply shall include a built-in UPS such that the controller remains fully operational during a power loss. A built-in alarm shall signal the central monitoring workstation that the controller is operating on battery power. Provide at least 1-hour battery backup time.
- F. Network controllers shall use scalable I/O modules or cards for the cost-effective addition of monitoring points and access control points. Provide expansion capability for at least 32 points or doors. Input modules shall use universal inputs, accepting a voltage, current, digital, thermistor, counter, or supervised input type.
- G. For specific HVAC control applications, the IFCS shall employ small, standalone controllers, designed to be mounted on the equipment they control. These controllers shall communicate back to the primary network controller through a RS-485, two-wire field bus, minimum speed 9,600 baud. The controllers shall be fully standalone, containing a central processor, memory, and all inputs and outputs needed for the application. In the event of a loss of communications to the network controller, the local controller shall continue to control its equipment and buffer alarms. When communications is restored, the alarms shall be delivered automatically to the network controller.
- H. All controllers shall be UL listed for Energy Management Systems (UL 916).
- I. UL 864 UUKL Compliance: All IFCS components associated with HVAC equipment utilized for smoke control shall be UL 864 UUKL listed and installed in strict accordance with UL 864 UUKL requirements. Contractor shall provide a UL 864 UUKL Smoke Control Compliance Report documenting product and installation compliance. All IFCS components not associated with smoke control shall be isolated from the UL 864 UUKL network segment utilizing UL 864 UUKL listed communications hardware.

1.5 OPERATOR INTERFACE

- A. Day-to-day operation of the IFCS shall be through a standard browser-based interface. Configuration, programming, and badging operations shall be performed on dedicated operator workstations.

1.6 OPERATOR WORKSTATION

- A. The IFCS shall support a PC-based, graphical operator workstation, providing a single-seat interface to all building subsystems. The workstation shall be connected to a central SQL-based database server, ensuring synchronization of all logs and archives, database parameters and configuration. The Division 25 contractor shall coordinate integration with the Owner's operating system and network. The workstations shall be able to be located anywhere on the Ethernet network without additional network hardware.
- B. The operator workstation shall present all alarms in real-time in an active alarm window, with each alarm color-coded based on priority or type. Alarms from all building subsystems shall be displayed in this window. Operators shall be able to set all alarm thresholds and setpoints (except Fire Alarm) from the central workstation. Changes to alarm parameters shall take effect immediately, with no additional commands required.
- C. Additionally, the IFCS shall be able to send alarms via email. All pertinent alarm data shall be included in the email – date, point name, description, value, and alarm message/instructions. Email recipients shall be defined using standard address book features on the central workstation's email client.
- D. The operator workstation shall provide a primary means to manage card records for access control. Operators shall be able to issue cards, edit and delete cards, grant access rights, and create photo ID credentials, from their workstation. Operator shall be able to issue batch commands such that all cards from a certain group are locked out of certain sites. These commands shall occur immediately, with no additional download commands required.
- E. The operator workstation shall provide graphical floor plans of the building, showing point values and critical alarm points dynamically. HVAC values, security values, fire alarm values, etc. shall all be shown on the same graphic panel, providing the operator one interface to the IFCS.
- F. Photo ID creation shall be performed at the operator workstation, using either a high-resolution (3 mega-pixel) digital camera, or, live video feed into the workstation. Provide a complete setup including lighting, tripod and backdrop. If a digital camera is provided, the camera must offer a live feedback screen for the operator. Picture images shall be stored in industry-standard JPEG format.
- G. Operator Workstation Requirements (Located in Facility Manager's Office):
 - 1. 3.6 GHz Pentium 4 Processor (Minimum).
 - 2. 512 MB RAM.
 - 3. 24 GB Hard Disk Drive.
 - 4. 8 x 4 x 32 Internal CD Rewriter/Recorder.
 - 5. 3-1/2" 1.44 MB Floppy Drive.
 - 6. (4) 17" flat screw, LCD Monitors .25 Dot Pitch or Better.
 - a. One for alarms, one for HVAC, one for video, one for security and fire.
 - 7. 10/100 MB Ethernet Card (Intel).
 - 8. 32 MB SVGA Video Card Capable of 24-Bit True Color.
 - 9. 101 Key Enhanced Keyboard.
 - 10. 2-Button (with wheel) Microsoft Intel mouse.
 - 11. Microsoft Windows XP.
 - 12. Manufactured by Compaq, Dell, or IBM.

1.7 SERVERS

- A. Provide servers that shall provide archive locations for all historical data such as trends, alarm and event histories, and transaction logs.
- B. Equip servers with the same tool set that is located in the primary application nodes for the system configuration and custom logic definition.
- C. Equip servers with the same tool set that is located in the primary application nodes for graphic configuration.
- D. Access to all information on the server shall be through the same user interface used to access individual nodes. When logged onto a server the operator shall be able to also interact with any of the primary nodes in the facility.
- E. The hardware platform for servers shall, at minimum, consist of:
 - 1. Pentium IV Class PC processor, minimum 2.4 GHz processor speed.
 - 2. Minimum 2 gigabyte RAM.
 - 3. Hard drive or equal high-speed data storage, minimum 120 gigabytes.
 - 4. Window 2000 Server operating system software.
 - 5. Microsoft SQL Server 2000 database software.
 - 6. Removable high-speed data storage and export device: 52x/24x/52x CD-RW drive.
 - 7. Full ASCII keyboard and digital Mouse or equal pointing device.
 - 8. Full color, flat panel LCD monitor, minimum 17 inches diagonal screen, minimum 1280 x 1024 resolution, 0.26 or better pixel pitch.
 - 9. Ethernet 10/100Mbps network interface card.
 - 10. Color Printer: Inkjet, 4800x1200 dpi resolution, 18 ppm black and white and 14 color print speed, 8 MB RAM.
 - 11. Uninterruptible Power Supply (UPS) sized for sufficient capacity to provide backup power for a minimum of 10 minutes.

1.8 BROWSER-BASED OPERATION

- A. Day-to-day operation of the IFCS shall be accessible through a standard web browser interface, allowing technicians and operators to view any site in the system from anywhere on the network.
- B. The IFCS shall be compatible with Microsoft Internet Explorer 5.0 and higher.
- C. The browser-based interface shall share the same graphical displays as the Operator Workstation, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall also support commands to change setpoints, enable/disable equipment and start/stop equipment.
- D. Through the browser interface, operators shall be able to navigate through the entire system, and change the value or status of any point in any controller. Changes shall be effective immediately to the controller, with a copy stored in the system database.
- E. Through the browser interface, operators shall be able to view pre-defined groups of points, with their values updated automatically.
- F. Through the browser interface, operators shall be able to change schedules – change start and stop times, and add new times to a schedule.
- G. Through the browser interface, operators shall be able to create and edit access control personnel records, and assign access to any or all doors.
- H. Through the browser interface, operators shall be able to view reports of access events and access privileges. Reports shall be available based on start and end time, door, area, and person. Invalid attempts shall be color-coded red in the report.

- I. Through the browser interface, operators shall be able to view live and recorded video from any digital video recorder on the network. The interface shall offer an easy method of selecting the camera to view, and for recorded video, shall offer selections for start and stop time when searching video clips.
- J. All commands and user activity through the browser interface shall be recorded in the systems activity log, which can be later searched and retrieved by user, date, or both.
- K. The same user accounts shall be used for the browser interface and for the operator workstations. Operators shall not be forced to memorize multiple passwords.
- L. The IFCS shall be expandable to up to 100 concurrent browser-based users. For this project, provide initially for 10 concurrent users.

1.9 ALARM MONITORING

- A. The IFCS shall monitor and report alarms to the central workstation as well as 3 user-defined PCs within 3 seconds of initial triggering. Alarms shall be buffered and time-stamped in the network controller, and sent up to the workstations for processing. If the alarm is not delivered to at least one workstation, then the controller shall buffer the alarm and try again, on a pre-determined time pattern. Network controllers shall be able to buffer every alarm condition in this manner.
- B. Any input or output point, software point such as a setpoint or calculated value, or data point from a third-party system shall be capable of sending alarms to central workstation. Up to 5 different alarm conditions shall be configured and attached to each point.
- C. Alarm conditions shall be defined as simple on/off conditions, comparisons to an analog value, comparison to an analog setpoint, comparison to a supervised circuit (for security alarms) or any combination of the above. Systems that deploy only on/off alarm conditions are unacceptable.
- D. All on/off digital alarms shall be configured such that a Closed circuit condition is normal, and an Open circuit is alarm.
- E. Alarm delivery shall be configurable such that different types of alarms may be delivered to different workstations. For example, all power alarms may go to the facilities manager, and all access control alarms may go to the security officer. Further, alarm delivery shall be configurable based on time of day and day of week – during the day, power alarms are delivered to the power specialist, but at night, they get routed to the security officer.
- F. Intrusion alarms monitored by the system shall be able to be shunted by a time schedule, or automatically shunted locally after a valid card access transaction at the local site.

1.10 HVAC CONTROL

- A. Refer to Division 23 Sections "Instrumentation and Control for HVAC," "Laboratory Airflow Control Systems," and "Sequence of Operation."
- B. Under this Section, place all systems into proper operation and fully integrate systems into the IFCS.
- C. All equipment controlled by these HVAC sub-systems shall be able to be controlled from the central workstations, through the graphic display panels, subject to the operator's user privileges.
- D. Electrical Equipment Monitoring:
 - 1. Refer to Division 26 Sections "Switchboards," "Emergency Power Generation," and "Electric Power Management System" for equipment requiring monitoring throughout IFCS.
 - 2. Under this Section, fully integrate all monitoring and alarm points into IFCS.

3. Refer to Division 23 Section "Sequence of Operation for HVAC Controls" for required monitoring points and report formats.

E. Laboratory Alarm Monitoring:

1. The system shall be capable of monitoring alarm points from laboratory equipment. The alarm points shall be either digital contact input points, or shall be monitored through a serial interface to the site equipment. Where a serial interface is proposed, the supplier shall specify which protocol the system will use to monitor the alarms.
2. Alarms shall be displayed and prioritized within the central workstation's active alarm viewer, and will be logged at the central file server.
3. Refer to Division 23 Section "Sequence of Operation for HVAC Controls" for laboratory alarm points.

1.11 SECURITY

- A. Refer to Division 28 Sections "Access Control," "Intrusion Detection Systems," and "Closed Circuit TV Systems."
- B. Under this Section, place systems in to proper operation and fully integrate systems into the IFCS.
- C. All access control alarms – forced entry, door ajar, invalid attempt, tamper – shall be reported to the central workstations, prioritized, and displayed in the active alarm window for assessment and acknowledgement by the operator.
- D. Coupled with video surveillance, any access control alarm shall automatically display the appropriate camera view of the alarm at the central workstation. The operator can then select previous video clips of the same alarm point, including a configurable pre-alarm segment; to assess conditions immediately before the alarm occurred.
- E. Through a graphical icon on the central workstation, an operator may call up any DVR unit on the network, and choose to view live video from any camera or cameras (up to 32 per screen). The interface shall allow cameras from different DVR units to be displayed on the same screen.
- F. Searching for video clips shall be intuitive, and shall allow for searching by DVR unit, camera(s), start date, and stop date. Additionally, the search shall be able to be further refined by field of motion – return only those clips that have motion in a certain portion of the view.
- G. The DVR units shall be seamlessly integrated with the access control and alarm monitoring functions, such that any alarm (door forced open, motion sensor, generator failure, high temp, etc.) shall be able to be linked to any camera. When the alarm is triggered, the central workstation interface shall automatically bring up the live view of the primary camera for that alarm. Up to 4 cameras shall be able to be defined per alarm point, and the operator may among the other cameras for complete alarm assessment.
- H. When presented with the alarm video, the operator may choose to review all alarm activity for the particular alarm point, searching by start and stop date. The operator may then select any alarm event and bring up the corresponding video clip.

1.12 FIRE SYSTEM ALARMING

- A. The system shall monitor all alarm points from the building's fire alarm system and early warning smoke detection system, and provide secondary fire annunciation to the central workstations.
- B. When practical, the system shall monitor the fire alarm values through a serial interface to the fire panel. When a serial interface is used, the system shall provide for all conditions of each alarm point – alarm, normal, trouble, fault, and reset.
- C. When a fire alarm or early warning smoke detection alarm is triggered, the system shall perform all necessary fan shutdown and smoke management procedures.

- D. Fire alarms shall take priority over other alarms in the system, and at the central workstation, shall automatically display a graphic panel when triggered.

END OF SECTION 255105

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SECTION 255110 - INTEGRATED EVENT MANAGEMENT SYSTEM (IEMS)

PART 1 - PRODUCTS

1.1 ACCEPTABLE MANUFACTURERS AND INSTALLERS

- A. Manufacturers: Subject to compliance with requirements, provide Integrated Event Management System by one of the following:
 - 1. ConnexALL, a Division of Globe Star Systems.
 - 2. Emergin, a Division of Philips.
- B. Installers: An authorized factory representative or a branch office of an acceptable manufacturer shall install the IEMS.

1.2 REGULATORY REQUIREMENTS

- 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.

1.3 IEMS ARCHITECTURE

- A. IEMS database shall administer and manage real-time event processing and dispatching across Owner's TCP/IP protocol based network between IEMS server and independent client systems.
- B. The IEMS database shall be accessed by the Owner's authorized representatives through a Graphical User Display (GUD) on a network PC or PC's defined by the Owner.
- C. The GUD shall provide an intuitive user interface for:
 - 1. Real-time assignments and viewing of the status of active incoming events (event points or EPs).
 - 2. Real-time assignments of an EP to remote devices (notification points or NPs).
 - 3. Real-time assignment of EP priority levels.
 - 4. Escalation of priority level given if the EP is not cancelled in a preset period of time.
 - 5. Systems and point type additions.
 - 6. Customized reporting development and initiation.
- D. Event point (EP) priority levels shall be:
 - 1. Primary.
 - 2. Secondary.
 - 3. Backup.
- E. Notification point (NP) devices shall consist of
 - 1. E-mail.
 - 2. Cellular telephone.
 - 3. Telephone.
 - 4. Wireless telephone.
 - 5. Pocket Pager.
 - 6. PDA.
 - 7. **[Insert other.]**
- F. Notification point user may take the following actions:
 - 1. Acknowledge or cancel the EP.
 - 2. Escalate the EP to the next priority level

3. Callback on the EP initiation device if the EP is audio-enabled and supports the callback feature.
 - G. Database: Logs shall include date, point name, description, value, alarm message/instructions, and EP and NP point address information and priority.
 - H. Reporting: Customized reports shall be provided to indicate single point accountability and trending for set up notification points by event point including menus for point descriptions, actions, date and time of alarms, and notification messages.
 - I. Scalability: The event collection shall be scalable for system expansion.
- 1.4 IEMS SERVER
- A. Rack mounted **[supplied by Owner]**.
 - B. Single **[and redundant]** unit.
 - C. Dedicated for IEMS database.
 - D. Operating System: Minimum Windows 2000, XP, NT
 - E. Hardware:
 1. Minimum 16 GHz Pentium 4 processor.
 2. Minimum 512 MB RAM.
 3. Minimum 40 GB hard drive space.
 4. 10/100/1000 GB network interface adapter.
 5. TCP/IP protocol.
 6. **[Uninterruptible Power Supply (UPS) sized for sufficient capacity to provide backup power for a minimum of 10 minutes.]**
- 1.5 IEMS PC
- A. Supplied by Owner.
- 1.6 CLIENT SYSTEMS
- A. Event point systems and point type(s):
 1. BAS Signal: **[Dry Contact][Network]**
 2. Blood Bank Alarm: **[Dry Contact][Network]**
 3. Code **[99][Blue]** Signal: **[Dry Contact][Network]**
 4. EPMS Signal: Dry Contact
 5. Fire Alarm Signal: **[Dry Contact][Network]**
 6. Medical Equipment Alarm: Dry Contact
 7. Medical Gas Alarm: Dry Contact
 8. Network Alarm: Network
 9. Network Message/Scheduling: Network
 10. Email Message: Network
 11. Patient Info HL7 Alarm/Message: Network
 12. Nurse Call System: Network
 13. Security Alarm:
 - a. Access Control: Network
 - b. CCTV Virtual: Network
 - c. Door Monitoring: Network
 - d. Panic Switch: Network
 14. IP Based Telephony Signal: Network

15.	Tracking – Asset:	Network
16.	Tracking – Patient:	Network
17.	Tracking – Staff:	Network
18.	Wireless Telephone:	Network
19.	Wireless IP Badges (Vocera):	Network

B. Notification point systems and point type(s):

1.	BAS Message:	Network
2.	Network Alarm/Message:	Network
3.	Email Message:	Network
4.	Cellular Telephone Message:	Network
5.	IP Based Telephony Message:	Network
6.	Wireless IP Badge Message:	Network
7.	Wireless Telephone Message:	Network
8.	Pocket Pager Message:	Network
9.	PDA Message:	Network
10.	Network Display:	Network
11.	Nurse Call System	Network
12.	Security Message:	Network
13.	Whiteboard Display:	Network
14.	Dry Contact:	Network

1.7 COMMUNICATION PROTOCOL REQUIREMENTS

- A. The **[new][existing]** facility wide network utilizes Open Standard protocols over the IEEE 802.3 Ethernet infrastructure for the purposes of integrating individual systems. Networked client systems will allow all contact point or serial communication (network) values to be accessed for EPs and NPs from a standard browser environment. IEMS middleware shall provide client systems integration. Contact point signals shall be monitored or controlled by the IEMS system addressable relays for linked serial communication.
- B. Client systems establish a communication link with the IEMS server using server connection setup options which shall be used to:
1. Verify registration.
 2. Establish proper communications.
 3. Provide user interface.
- C. All event, notifications, and other command and control features are communicated from the client systems to the IEMS server.
- D. IEMS server shall ensure synchronization of all logs and archives, database parameters, and configuration.
- E. IEMS server interface to client systems shall upload:
1. Priority of events.
 2. System EP and NP settings.
 3. Changes.

1.8 ADDRESSABLE RELAY

- A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for hard-wired applications with auxiliary contacts.
1. Integral Relay: Provide a direct control signal for hard-wired applications with input contacts.

1.9 IEMS SYSTEM CABLING

- A. **[Existing]**Network structured cabling system per Division 27 Section "Structured Telecommunication Cabling System."
- B. Dry contact connections shall be per Division 26 requirements.

END OF SECTION 255110

SECTION 260505 - ELECTRICAL INSPECTIONS AND TESTING

PART 1 - GENERAL

A. Testing Responsibility Matrix:

System	Testing Agency
Automatic Lighting Control Equipment	C
Central Battery Inverter Systems	I
Control Voltage Electrical Power Cables	C
Contactors	C
Dimming Systems	C
Disconnect Switches	C
Electricity Metering	C
Electric Power Management Systems	I
Electric Vehicle Charging Stations	C
Electric Service Substation	I
Engine Generator Sets	I
Equipotential Grounding Systems	I
Exterior Athletic Lighting	C
Exterior Lighting Systems	C
Exterior Medium Voltage Pad-Mounted Vacuum Interrupter Switchgear	I
Grounding Systems	I
Harmonic Filter Systems	I
Integrated Power Center Switchboards	I
Interior Lighting	C
Isolated Power Systems	I
Lighting Control Equipment	I
Lightning Protection Systems	C
Load Bank	C
Local Dimming Systems	C
Low Voltage Generator Plant Modification	I
Low Voltage Power Switchgear	I
Low Voltage Transformers	I
Medium Voltage Automatic Power Factor Correction	I
Medium Voltage Cable	I
Medium Voltage Regulators	I
Medium Voltage Switchgear	I
Medium Voltage Transformers	I
Metering Equipment	I
MI Cable	I
Motor Control Centers	I

System	Testing Agency
Motor Controllers	I
Networked Lighting Control Equipment	C
Panelboard SPD	C
Panelboards	C
Photovoltaic System	I
Pre-fabricated MC Wiring System Assemblies	I
Primary Substation	I
Primary Substation Transformers	I
Protective Device Coordination	I
Protective Devices	I
Surge Protection Devices	I
Switchboards	I
Transfer Switches	I
Uninterruptible Power Supplies	I
Unit Substations	I
Vibration and Seismic Controls	I

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT GENERAL REQUIREMENTS

- A. Use only test equipment that is in good mechanical and electrical condition.
- B. Use true RMS measuring meters.
- C. Field test metering used to check power system meter calibration shall have an accuracy higher than that of the instrument being checked.
- D. Use test equipment with accuracy of metering that is appropriate for the test being performed.
- E. Use test equipment with waveshape and frequency output that are appropriate for the test and tested equipment.
- F. Utilize third party for megger wiring tests.

2.2 TEST EQUIPMENT QUALITY CONTROL

- A. Use only equipment for testing and calibration procedures that has the following characteristics:
 1. Maintained in good visual and mechanical condition.
 2. Maintained in safe operating condition.
- B. Use test equipment having operating accuracy equal to, or better than, the following limits:
 1. Portable Multimeters: True RMS measuring.
 2. Multimeters shall have the following accuracy limits, or better:
 - a. AC Voltage Range: .75% +/- 3 last single digits @ 60 Hz.
 - b. AC Current Range: .90% +/- last single digits @ 60 Hz, including adapters, transducers.
 - c. DC Voltage Range: .25% +/- 1 last single digit.
 - d. DC Current Range: .75% +/- 1 single digit.
 - e. Resistance Range: .50% +/- 1 last single digit.

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- f. Frequency Range: .10% +/- 1 single digit @ 60 Hz.
- 3. Clamp-on Ammeters: AC current +/- 3% of range +/- 1 last single digit @ 60 Hz.
- 4. Dissipation/Power Factor Field Equipment:
 - a. +/- 0.1% power factor for power factor values up to 2.0%.
 - b. 5% of the reading for power factor values above 2.0%.
- 5. Low Range DC Resistance Equipment: 1.0% of reading, +/- 2 last single digits.
- 6. Transformer Turns Ratio Test Equipment: 0.5% or better @ 60 Hz.
- 7. Ground Electrode Test Equipment: +/- 2% of range.
- 8. Insulation Test Sets: 0-1000V DC +/- 20% of reading at mid-scale.
- 9. Electrical Load Survey Equipment:
 - a. +/- 5% total error, including sensors.
 - b. 1% resolution.
 - c. Current Transformers: +/- 2% of range @ 50 Hz.
 - d. Voltage Transformers: +/- 0.5% of range @ 60 Hz.
- 10. Liquid Dielectric Strength Test Equipment: +/- 2% of scale.
- 11. Infrared Scanning Equipment: Sensitivity of 2C.
- 12. Phase Shifting Equipment: +/- 1.0 over entire range.
- 13. High Current Test Equipment: +/- 2% or range.
- 14. DC High Potential Test Equipment: +/- 2% of full scale.
- 15. AC High Potential Test Equipment (60 Hz): +/- 2% of full scale.

2.3 TEST EQUIPMENT CALIBRATION

- A. Test instruments shall be calibrated to references traceable to the National Bureau of Standards and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.
- B. Calibrate equipment in accordance with the following schedule:
 - 1. Field Equipment: 6 months maximum.
 - 2. Leased Specialty Equipment: 12 months (where accuracy is guaranteed by lessor).
- C. Place dated calibration labels at visible locations on all test equipment.
- D. Keep up to date records which show date and results of test equipment calibrated or tested; have such records available for review.
- E. Maintain up to date test equipment calibration instructions and procedures for each test equipment.
- F. Use calibration standards of higher accuracy than the accuracy of the test equipment being calibrated.

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SECTION 260533 - RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Homeruns shall only be 25% filled to provide future space capacity. Underground conduit shall be a minimum 1" conduit. Indoor conduit shall be a minimum ¾" conduit. For underground conduit feeders, provide additional conduit (where feasible) for future expansion. Coordinate with Project Team. No flexible conduit is allowed in walls. Route underground conduit above grade 6" before transitioning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Rigid Metallic Conduit:
 - a. Allied, a Division of Tyco.
 - b. Republic Conduit.
 - c. Wheatland Tube Co.
2. Rigid Aluminum Conduit:
 - a. Allied, a Division of Tyco.
 - b. Alumax.
 - c. New Jersey Aluminum.
 - d. VAW Aluminum.
3. PVC Coated Rigid Steel Conduit and Fittings:
 - a. Ocal, a Division of Thomas and Betts.
 - b. Perma-Cote Industries.
 - c. Rob-Roy.
4. Rigid Nonmetallic Conduit and Fittings:
 - a. Allied, a Division of Tyco.
 - b. Can-Tex.
 - c. Carlon.
 - d. Condux.
 - e. IPEX.
 - f. National.
5. Flexible Nonmetallic Conduit and Fittings:
 - a. Arnco Corporation.
 - b. Endot Industries, Inc.
 - c. Carlon Plenum-Guard.
 - d. Kwikpath, IPEX, Inc.
6. Flexible Metal Conduit and Fittings:
 - a. AFC Cable Systems, a Division of Tyco.
 - b. Al-flex (Steel).
 - c. Liquatite.

7. Liquidtight Flexible Metal Conduit and Fittings:
 - a. AFC Cable Systems, a Division of Tyco.
 - b. Al-flex.
 - c. American Flexible Conduit.
 - d. Anamet, Inc.
 - e. Electro Flex.
 - f. Liquatite.
 - g. PDU Cables.
 - h. RACO.
8. Conduit Bodies:
 - a. Appleton Electric Co.
 - b. Carlon (PVC).
 - c. Crouse-Hinds Division, Cooper Industries, Inc.
 - d. Killark Electric Mfg. Co.
 - e. O-Z/Gedney.
9. Conduit Fittings:
 - a. Allied, a Division of Tyco.
 - b. Arlington.
 - c. Bridgeport Fittings, Incorporated.
 - d. Cooper Crouse-Hinds.
 - e. Midwest Electric.
 - f. O-Z/Gedney.
 - g. RACO.
 - h. Steel City.
 - i. Thomas and Betts.
10. Wireways and Auxiliary Gutters:
 - a. Hoffman Engineering Co.
 - b. Lee Products Co.
 - c. Walker-Parkersburg.
11. Surface Metal Raceway:
 - a. Hubbell, Inc.
 - b. Mono-Systems.
 - c. Post Glover Life Link.
 - d. The Wiremold Co. 500 Series; a Div. of Legrand.
12. Surface Metallic Raceway:
 - a. Hubbell, Inc. 3000 and 4800 Series and ALU3800 and ALU4800 Series.
 - b. Mono-Systems, Inc. SMS3000, SMS4200, and SMS4800 Series.
 - c. Post Glover Versa-Duct 100 and 200 Series.
 - d. The Wiremold Co. G3000, AL3100, and G4000 Series; a Div. of Legrand.
13. Multi-Outlet Assemblies:
 - a. Hubbell, Inc. Metal PlugTrak.
 - b. Mono-Systems.
 - c. The Wiremold Co. 2400 Series; a Div. of Legrand.
14. Aluminum Surface Raceway:
 - a. As fabricated by local fabricators.
 - b. Mono-Systems.

2.2 REGULATORY REQUIREMENTS

- 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. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. NEMA, FB1 Fittings for Metallic Conduit
 - b. NEMA, RN 1 PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
 - c. NEMA, TC2 Schedule 40 and Schedule 80 PVC
 - d. NEMA, TC 3 PVC Fittings for Use with Rigid PVC Conduit and Tubing
 - 2. American National Standards Institute (ANSI):
 - a. ANSI-C80.1 Rigid Steel Conduit
 - b. ANSI-C80.2 Rigid Steel Conduit, Enameled
 - c. ANSI-C80.3 Electrical Metallic Tubing, Zinc-coated
 - d. ANSI-C80.6 Intermediate Metal Conduit (IMC)
 - 3. American Society for Testing Materials (ASTM):
 - a. ASTM F 512-84 Standard Specification for Smooth Wall Poly Vinyl Chloride (PVC) Conduit and Fittings for Underground Installation
- D. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, or ETL:
 - 1. UL 1 Flexible Metal Electrical Conduit
 - 2. UL 5 Surface Metal Electrical Raceways and Fittings
 - 3. UL 6 Rigid Metal Electrical Conduit
 - 4. UL 360 Liquidtight Flexible Steel Conduit, Electrical
 - 5. UL 514B Fittings for Conduit and Outlet Boxes
 - 6. UL 651 Schedule 40 and 80 PVC Conduit
 - 7. UL 797 Electrical Metallic Tubing
 - 8. UL 870 Electrical Wireways, Auxiliary Gutters, and Associated Fittings
 - 9. UL 910 and 2024 Plenum Optical Fiber Raceways
 - 10. UL 1242 Intermediate Metal Conduit

2.3 METAL CONDUIT AND TUBING

- A. Rigid Galvanized Steel Conduit: ANSI C80.1.
- B. Intermediate Steel Conduit: UL 1242.
- C. PVC Externally Coated Rigid Steel Conduit and Fittings: ANSI C80.1 and NEMA RN 1.
- D. Electrical Metallic Tubing and Fittings: ANSI C80.3.
- E. Flexible Metal Conduit: UL 1, zinc-coated steel.
- F. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

2.4 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit: NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
- C. Conduit and Duct Accessories: Types, sizes, and materials complying with manufacturers published product information. Mate and match accessories with raceway.

2.5 OPTICAL FIBER AND COMMUNICATIONS RACEWAY (INNERDUCT) FITTINGS

- A. General: UL 910 approved corrugated plenum optical fiber raceway for telecommunications plenum, riser, and general purpose cable applications per CEC Articles 770 and 800.
- B. Raceway shall be supplied with a factory installed 1250 lb. tensile pre-lubricated pull tape.
- C. Raceway shall be per Division 26 Section "Electrical Identification."

2.6 CONDUIT BODIES

- A. General: Types, shapes, and sizes as required to suit individual applications and CEC requirements for feeder runs only. Branch circuit use is prohibited. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways. Use bodies with set screw or compression type hubs for EMT according to fitting application specified below.
- C. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.

2.7 CONDUIT FITTINGS

- A. General: Types, shapes, and sizes as required to suit individual applications and CEC requirements. Die cast fittings are not acceptable.
- B. Rigid Galvanized Steel, Intermediate Steel and Rigid Aluminum Conduit: Use threaded type with bushed connections. Factory-installed conduit couplings are acceptable.
- C. Electrical Metallic Tubing Conduit: Use nylon insulated fittings. Steel body or integral conduit sleeve dual double set-screw type fittings are acceptable for EMT conduits except for mechanical rooms, kitchens and damp locations where threaded compression types are required. Die cast fittings are not acceptable.
 - 1. Nylon fittings may be eliminated if rounded box teeth type fittings are used (i.e., Cooper Crouse Hinds Space Saver).
 - 2. Colored fittings may be used to meet raceway identification requirements of Division 26 Sections "Boxes and Cabinets" and "Electrical Identification."
- D. Rigid Nonmetallic Conduit: Use fittings designed specifically for conduit type of same manufacturer.
- E. Reinforced Thermosetting Resin Conduit: Use fittings designed specifically for conduit type of same manufacturer.
- F. Flexible Metal Conduit: Use nylon insulated throats of the following type:
 - 1. Wedge and screw type.
 - 2. Squeeze on clamp type with one or two screws.
 - 3. Steel multiple-point type for threading into internal wall of conduit.

- G. Liquidtight Flexible Conduit: Use threaded grounding cone with steel compression ring and tightening gland, steel body with insulated throat.
- H. Unlike Conduit: Use connectors which meet individual conduit fittings requirements for both and are UL listed and labeled for such use.
- I. Rigid Metallic Conduit Expansion and Deflection Fittings:
 - 1. Conduit movement in straight line direction:
 - a. Crouse-Hinds XJG Series; a Division of Eaton.
 - b. O-Z/Gedney Type AX Series.
 - 2. Up to 3/4 inch deflection and movement in all directions:
 - a. Crouse-Hinds XD Series; a Division of Eaton.
 - b. O-Z/Gedney Type DX Series.
 - 3. Deflection and movement beyond 3/4 inch in all directions:
 - a. Crouse-Hinds XJGD Series; a Division of Eaton.
 - b. O-Z/Gedney Type AXDX Series.
- J. Rigid Nonmetallic Conduit Expansion and Deflection Fittings:
 - 1. Conduit movement in straight line direction:
 - a. Carlon E945 Series.
 - b. Platt EXPCP Series.
 - c. Scepter EJ Series.
 - 2. Up to 3/4 inch deflection and movement in all directions:
 - a. Calbond Type XD Series.
 - b. Carlon XD Series; a Division of ABB.
- K. Conduit Bushings:
 - 1. Rigid Steel and Intermediate Steel Conduit: Threaded, grounded, insulating type with thermosetting or fiber insert in a metal body.
 - 2. Electrical Metallic Tubing Conduit: Identical to rigid steel or intermediate steel conduit bushing on electrical metallic tubing combination coupling.
 - 3. Insulated Grounding Bushings or grounding wedges on metallic conduits shall be installed per Division 26 Section "Grounding and Bonding."
 - 4. Plenum Conduit: UL approved for air handling spaces when so installed.
- L. Conduit Seals:
 - 1. Cast in place with pressure ring and sealing grommet:
 - a. O-Z/Gedney Type FSK Series with FSKA membrane clamp adapter.
 - 2. Cast in place with two pairs of pressure rings and sealing grommets:
 - a. O-Z/Gedney Type WSK Series.
 - 3. For sealing conduits installed in core-drilled, sleeved, or precast holes:
 - a. O-Z/Gedney Type CSM Series with CSMC membrane clamp adapter.
 - b. Thunderline Link-Seal Series.

2.8 SURFACE RACEWAYS

- A. General: Sizes and channels as shown on Drawings. Provide fittings that match and mate with raceway.

- B. Surface Metal Raceway: Construct of galvanized steel or extruded aluminum with snap-on covers, with 1/8 inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for finish paint selected by Architect. Provide one wire clip for every 12 inch length of raceway for holding conductors in place.

2.9 WIREWAYS AND AUXILIARY GUTTERS

- A. General: Electrical metal wireways and auxiliary gutters shall be generally NEMA 1 construction of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, connectors, tees, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Provide corrosion resistant phosphate primer and baked gray epoxy finish. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of CEC and NEMA standards.
- B. Wireway covers shall be hinged type, as indicated, otherwise screw cover type.

2.10 MULTI-OUTLET ASSEMBLIES

- A. Two-piece continuous outlet system equipped with knockouts for 1/2 inch conduit at approximately 8 inch centers and screw knockouts/piercings on 2 inch centers. Snap-on cover with openings on 6 inch centers for single NEMA 5-20R receptacle with openings on 6 inch centers for single NEMA 5-20R receptacle with white face. Receptacles arranged for two circuit (alternate receptacles on opposite circuit) three-wire operation and prewired with #12 AWG THHN or THWN insulated copper conductors. Red face receptacles or receptacle red marking tag shall be utilized if connected to emergency circuits. Finish shall be as selected by Architect except in laboratory areas where anodized aluminum shall be utilized. Wiring devices shall conform to Division 26 Section "Wiring Devices" as appropriate.
- B. Provide end caps, feed section and additional fittings required to accomplish the arrangement indicated. Provide blank sections at sinks as indicated or required.

PART 3 - EXECUTION – NOT USED

END OF SECTION 260533

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:

1. Brady USA, Inc. Industrial Products Division.
2. BW Industries, Inc.
3. Ideal Industries, Inc.
4. Rhino/DYMO, a Newell Rubbermaid Company.
5. Seton Name Plate Corporation.

2.2 PERFORMANCE REQUIREMENTS

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70 and NFPA 70E.
- C. Comply with 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E and Division 26 Section "Protective Device Coordination" requirements for arc flash warning labels.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- G. Adhesive attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.3 FONT

- A. Arial uppercase.
- B. Text abbreviations other than equipment identifications permitted only as approved.

2.4 COLOR CODING REQUIREMENTS

- A. Provide CEC electrical distribution branch color coding as follows:

1. Normal:
 - a. System ID or Nameplate: Black
 - b. Text: White
 - c. Conductors: Per associated Section
2. Generator:
 - a. System ID or Nameplate: Green
 - b. Text: White
 - c. Conductors: Per associated Section
3. Life Safety:
 - a. System ID or Nameplate: Yellow

- b. Text: Black
 - c. Conductors: Per associated Section
 - 4. Legally Required Standby:
 - a. System ID or Nameplate: Blue
 - b. Text: Black
 - c. Conductors: Per associated Section
 - 5. Optional, Non-Required Standby:
 - a. System ID or Nameplate: Orange
 - b. Text: Black
 - c. Conductors: Per associated Section
- B. Provide Division 23 systems color coding as follows:
 - 1. Building Automation System:
 - a. System ID or Nameplate: Orange
 - b. Text: Yellow
 - c. Cable Jacket: Orange with Yellow Stripe
- C. Provide Division 26 systems color coding as follows:
 - 1. Electric Power Management System:
 - a. System ID or Nameplate: Black
 - b. Text: White
 - c. Cable Jacket: Black with White Stripe
 - 2. Wiring Devices and Wall Plates:
 - a. System ID: Per associated Section
 - 3. Lighting Control Equipment and Systems:
 - a. System ID or Nameplate: Gray
 - b. Text: White
 - c. Cable Jacket: Gray with White Stripe
 - 4. Miscellaneous Control:
 - a. System ID or Nameplate: Gray
 - b. Text: Yellow
 - c. Cable Jacket: Gray with Yellow Stripe
- D. Provide Division 27 systems color coding as follows:
 - 1. Structured Cabling:
 - a. System ID/Cable Jacket:
 - 1) OF Multimode OM1/OM2 Orange
 - 2) OF Multimode OM3/OM4 Aqua
 - 3) OF Singlemode Yellow
 - 4) Copper backbone Gray
 - 5) Horizontal cable Blue
 - b. Nameplate/Text: Per EIA/TIA 606A
 - c. Raceway: Blue
 - 2. **[Public Address][Clock]:**
 - a. System ID/Cable Jacket: Gray

- b. Nameplate: Dark Brown
 - c. Text: White
 - d. Raceway: White
 - 3. Audio-Visual:
 - a. System ID/Cable Jacket: TP Purple or Coax Black
 - b. Nameplate: Dark Brown
 - c. Text: Yellow
 - d. Raceway: Black
- E. Provide Division 28 systems color coding as follows:
 - 1. Security:
 - a. System ID/Cable Jacket: White or Yellow
 - b. Nameplate: Dark Green
 - c. Text: White
 - d. Raceway: Yellow
 - 2. Door Monitoring and Access Control:
 - a. System ID/Cable Jacket: Yellow
 - b. Nameplate: Dark Green
 - c. Text: Yellow
 - d. Raceway/Innerduct: Yellow
 - 3. Rescue Assistance:
 - a. System ID/Cable Jacket: Orange
 - b. Nameplate: Red
 - c. Text: Yellow
 - d. Raceway: Orange
 - 4. Fire Alarm:
 - a. System ID/Cable Jacket: Red
 - b. Nameplate: Red
 - c. Text: White
 - d. Raceway: Red

2.5 RACEWAY AND 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. Color for System Identification and Printed Text:
 - 1. Per system or CEC branch color coding specified.
 - 2. Identification Label: Indicate system or service. Include branch and voltage text for CEC electrical distribution.
- C. 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.

2.6 BOX WIRING IDENTIFICATION MATERIALS

- A. Self-Adhesive Labels: Field machine printed by thermal transfer or equivalent process with System/Panelboard, Circuit No., and Load text.

2.7 CONDUCTOR, WALL PLATE, AND COMMUNICATION AND CONTROL CABLE 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. Marker Tapes: Vinyl or vinyl cloth, self-adhesive wraparound type, with circuit identification text machine printed by thermal transfer or equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.014 inch (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed text, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or aluminum, 2 x 2 x 0.05 inch (50 x 50 x 1.3 mm), with stamped text, punched for use with self-locking nylon tie fastener.
- E. Tie-On Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
- F. Self-Adhesive Write-On Tags: Vinyl type with black pre-printed "System/Panelboard:," "Circuit No.:", and "Load:" in three fill-in lines on white field.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.8 FLOOR MARKING TAPE

- A. 3 inch (75-mm) wide, 5 mil (0.12 mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.9 UNDERGROUND RACEWAY MARKING TAPE

- A. Heavy gauge, not less than 5 mils thick by 6 inches (150 mm) wide, polyethylene marking tape with integral metallic detection foil applied therein:
 - 1. Color: APWA Yellow.
 - 2. Wording: "CAUTION BURIED UTILITY LINE BELOW."
- B. Acceptable Manufacturers:
 - 1. Seton.
 - 2. Panduit Corp.
 - 3. Emedco.

2.10 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: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4 inch (6.4 mm) grommets in corners for mounting. Nominal size, 7 x 10 inches (180 x 250 mm).

- D. Metal Backed, Butyrate Warning Signs: 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. 1/4 inch (6.4 mm) grommets in corners for mounting. Nominal size, 10 x 14 inches (250 x 360 mm).

2.11 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved text 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. Electrical Assembly Single-Line:
 - 1. Framed acrylic screw mounted full size record drawing.
 - 2. Printed operating instructions may be included as an option to separate signage.

2.12 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting, color coded by system. Minimum letter height shall be 1/2 inch (6.4 mm).

2.13 EQUIPMENT TEST LABELS

- A. Adhesive Film Label: Machine printed, color coded by system, by thermal transfer or equivalent process. Minimum letter height shall be 1/2 inch (6.4 mm).

2.14 COMPONENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Minimum letter height shall be 1/4 inch (93.2 mm).

2.15 ABOVE CEILING EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Dot Label: 1/2 inch (64 mm) vinyl dot color coded by system.

2.16 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Per system color coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black.

- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 - 5. Color: Red.

2.17 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

2.18 BAR CODED IDENTIFICATION SYSTEM

- A. Bar Code Labels: 360 dpi high resolution 1 inch (25 mm), black on white tape suitable for indoor or outdoor use, and abrasion, water, and chemical resistant.
- B. Desktop Printer: Portable with carrying case, AC adaptor, batteries, and USB cable for download to PC.
- C. CD-ROM: Label design software and templates for label designs, graphics, and image transfers.
- D. Bar Code Scanner: Portable with desktop stand and USB cable for PC connection.
- E. Link to custom software in Division 26 Section "Electric Power Management Systems" for asset management and inventory control for all[**monitored**] devices and assemblies with labels.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Wiring Device and Coverplate Identification:
 - 1. General:
 - a. Wiring devices and coverplates shall be provided with specific identification.
 - b. ID shall be not less than 1/8 inch tall, uppercase letters and numerals.
 - 1) ID shall be engraved and paint stick filled after engraving.
 - c. Coverplate ID for wiring devices connected to a "normal" power branch circuit shall be engraved and filled in black color paint stick.
 - d. Coverplate ID for wiring devices connected to an "emergency" power branch circuit shall be:
 - 1) Engraved and filled in red color paint stick, where the coverplate is stainless steel, or other material, where the coverplate color is not red.
 - 2) Engraved and filled in white color paint stick, where the coverplate color is red.
 - 2. Wiring Devices:
 - a. Refer to Division 26 Section "Wiring Devices" for wiring device face color identification specifications.
 - b. Lighting control devices need not be specifically identified, except as follows:
 - 1) Preset Lighting Control Devices: Provide machine printed identification labels, indicating specifically the scene, luminaire group, or area, the device controls.

- c. Receptacles: Regardless of configuration, ampere rating, type, etc., shall each be provided with identification, as follows:
 - 1) The serving panelboard name/designation and circuit number shall be identified on the face or strap of receptacle.
- 3. Wiring Device Coverplates:
 - a. Refer to Division 26 Section "Wiring Devices" for coverplate face color identification specifications.
 - b. The following lighting control device coverplates shall be specifically identified:
 - 1) Where shown, noted, and/or otherwise identified.
 - 2) Where more than three (3) lighting control devices are ganged together at a common location, under a single coverplate, provide engraved ID, on face of coverplate, specifically identifying the luminaire group, or area, the devices control.
 - c. Coverplates for receptacles shall be provided with engraved ID, on face of coverplate in private spaces and on backside of coverplate for public spaces..
 - d. Single and duplex, NEMA 5-15R and 5-20R receptacles, connected to a "normal" power branch circuit, shall be provided with the following ID information, engraved, on face of coverplate:
 - 1) Serving Panelboard Name/Designation
 - 2) Branch Circuit Number
 - 3) Ex: 1LNL1-3
 - e. Single and duplex receptacles, other than NEMA 5-15R and 5-20R, connected to a "normal" power branch circuit, shall be provided with the following ID information, engraved, on face of coverplate:
 - 1) Operating Voltage/Phases
 - 2) Ampere Rating
 - 3) Serving Panelboard Name/Designation
 - 4) Ex: 208V/3PH/50A
1LNL1
 - f. Single and duplex, NEMA 5-15R and 5-20R receptacles, connected to any CEC Article 700, 701, or 702 branch circuit, shall be provided with the following ID information, engraved on face of coverplate:
 - 1) The word "EMERGENCY" - at/near top
 - 2) Serving Panelboard Name/Designation - at/near bottom
 - 3) Branch Circuit Number - at/near bottom
 - 4) Ex: EMERGENCY
1LGL1-4
 - g. Single and duplex receptacles, other than NEMA 5-15R and 5-20R, connected to any CEC Article 700, 701, or 702 branch circuit, shall be provided with the following ID information, engraved on face of coverplate:
 - 1) The word "EMERGENCY" - at/near top
 - 2) Operating Voltage/Phases - at/near bottom
 - 3) Ampere Rating - at/near bottom
 - 4) Serving Panelboard Name/Designation

5) Ex: EMERGENCY
208V/3PH/50A
1LGL1

- h. Coverplates on receptacles protected upstream by a ground fault circuit interrupter device shall also be provided with ID indicating "GFCI PROTECTED" on the face of coverplate.
- i. Coverplates for fractional horsepower manual motor starters shall be provided with engraved ID on face reading "DISCONNECT - EQUIPMENT DESIGNATION." Example: DISCONNECT – EXH. FAN EF01.

B. Warning Tapes, Labels, and Signs:

- 1. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground line warning tape for both direct-buried cables and cables in raceway.
- 2. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts per the coordination study in Division 26 Section "Protective Device Coordination." 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.
- 3. Warning Labels for Identification for Branch Circuit Ungrounded Conductors: Install at all branch circuit panelboards, cabinets, and enclosures per NFPA 70. Provide black engraved text on a white background. Apply to exterior of door, cover, or other access generally with rivets, not glued. Label where panel is fed from. For flush mounted panelboards in finished spaces, install on inside of protective device door.
 - a. For 208/120 volt systems, lines and text shall be:
 - 1) "208/120 VOLT SYSTEM"
 - 2) "PHASE A – BLACK"
 - 3) "PHASE B – RED"
 - 4) "PHASE C – BLUE"
 - b. For 480/277 volt systems, lines and text shall be:
 - 1) "480/277 VOLT SYSTEM"
 - 2) "PHASE A – BROWN"
 - 3) "PHASE B – ORANGE"
 - 4) "PHASE C – YELLOW"
 - c. For isolated power systems, lines and text shall be:
 - 1) For isolated power systems, lines and text shall be:
 - a) "207/120 VOLT ISOLATED POWER SYSTEM"
 - b) "PHASE A – BROWN"
 - c) "PHASE B – YELLOW"
- 4. Warning labels and signs shall include, but are not limited to, the following texts:
 - a. Low Voltage Room Door Sign: "DANGER - ELECTRICAL HAZARD – AUTHORIZED PERSONNEL ONLY."
 - b. Medium Voltage Equipment and Raceway Access Label: "DANGER – HIGH VOLTAGE."
 - c. Medium Voltage Room Door Sign: "DANGER – HIGH VOLTAGE – KEEP OUT."
 - d. Service Disconnect Sign: "SERVICE DISCONNECT."
 - e. Service Disconnect Sign: "AVAILABLE SERVICE FAULT CURRENT = XXXX/DATE: XX/XX/XX" per the coordination study in Division 26 Section "Protective Device Coordination."

- f. Generator Disconnect Sign: "GENERATOR XX DISCONNECT."
- g. Fire Pump Disconnect Sign: "FIRE PUMP DISCONNECT."
- h. Multiple Power Source Warning (locate at each service and generator disconnect equipment): "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES. STANDBY POWER SOURCE LOCATED IN _____ ROOM LOCATED AT _____ AREA OF BUILDING."
- i. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply [**baked-enamel warning signs**] **[metal-backed, butyrate warning signs]**. Identify system voltage with black text on an orange background. Apply to exterior of door, cover, or other access.
 - 1) Equipment with Multiple Power or Control Sources: Apply to front of equipment including, but not limited to, the following:
 - a) Transfer switches.
 - b) Controls with external control power connections.
- j. Fused and Non-Fused Motor Disconnect Switches: Install baked enamel warning sign with white legend on red background with minimum 3/8 inch high lettering with the following designation – "DANGER, DO NOT USE TO START OR STOP MOTOR. USE FOR ISOLATION ONLY."
- k. Back-Fed Switches and Circuit Breakers: Where switches and devices such as knife switches, circuit breakers, molded-case switches, and contactors are installed such that the load side of the switch device could energize with the switch open due to back feeding, provide a warning plate with the wording "WARNING – LOAD SIDE OF SWITCH MAY BE ENERGIZED BY BACKFEED", shall be installed on the switch.
- l. Arc Flash Hazard Warning: Per NFPA 70E requirements.
- m. Series Rated Protective Device Warning: Per NFPA 70 requirements.

C. Instruction Signs:

- 1. Operating Instructions: 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.
- 2. Emergency Operating Instructions: 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] emergency operations
- 3. Electrical Assembly Single-Line: Install at end of assembly having no future extension provisions or as otherwise shown on Drawings within sight of assembly.

END OF SECTION 260553

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SECTION 260913 - ELECTRIC POWER MANAGEMENT SYSTEMS

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by the manufacturer of Division 26 Section "Switchboards."

2.2 SYSTEM DESCRIPTION

- A. Microprocessor based monitoring and control of electrical power distribution system that includes the following:
 - 1. Electrical meters that monitor and connect to the data transmission network.
 - 2. LAN: High speed, multi access, open, nonproprietary, industry standard communication protocols.
 - 3. Include with web access, with its operating system and application software, connected to data transmission network.
 - 4. Integrate with Building Management System.
- B. The electrical power monitoring and control system shall be Internet based.
 - 1. System software shall be based on server thin client architecture, designed around open standards of internet technology.
 - 2. Intent of thin client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
 - 3. Internet access shall be password protected.
- C. Manufacturer/Product Selection: The Drawings indicate sizes, profiles, and dimensional requirements of medium voltage and low voltage equipment in which Electric Power Management System components may be installed. Be responsible to coordinate physical space and installation requirements for integration of components and structures and cost thereof.
 - 1. Startup Personnel Qualifications: Engage specially trained personnel who are directly employed by a manufacturer of distribution system protective devices.
 - 2. Installer Qualifications: An experienced installer who is an authorized representative of the power monitoring and control equipment manufacturer for both installation and maintenance of units required for this Project.
 - 3. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.
 - 4. Source Limitations: Obtain power monitoring and control software, firmware, monitoring panels, and network components from the same manufacturer as for distribution equipment circuit breakers and other protective devices.

2.3 REGULATORY REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Listed and labeled as complying with UL 61010-1.

- C. Listing and Labeling: Provide components that are listed and labeled for the application.
 - 1. The terms "listed" and "labeled": As defined in the National Electrical Code Article 100.
 - 2. UL 1244 for digital metering devices.
- D. NEMA Standard: Comply with NEMA Standards for applicable component installations within various distribution equipment.
- E. ANSI/IEEE Compliance: Comply with applicable requirements of ANSI/IEEE Standard C2, "National Electrical Safety Code" and ANSI/IEEE Standard C12.20 for Class 0.2 accuracy requirements.
- F. ANSI C37 90.1 Specific Compliance: Comply with surge withstand and high speed transient voltage requirements for electronic equipment.

2.4 CURRENT TRANSFORMERS (CTs)

- A. 600 Volts and Less:
 - 1. Main current transformers shall be 3 phase, window type with shorting switches, and have primary rating equal to or greater than the main device.
 - 2. Branch current transformers shall be 3 phase window type with shorting switches, factory mounted on branch device runbacks or switchboard frame, with primaries equal to frame rating of the device serviced.
- B. 5 - 15 KV:
 - 1. Current transformer shall be window type, rigidly mounted to the enclosure frame, with ratios required for proper monitoring, and six-point terminal strips.

2.5 POTENTIAL TRANSFORMERS (PTs)

- A. Potential transformers shall be rated for system phase-to-phase voltage.
- B. Potential transformers shall have current limiting fuses in clips accessible behind hinged panels.

2.6 LOAD/EQUIPMENT MONITOR UNITS

- A. Electronic load/equipment monitor units shall be a UL listed microprocessor-based device suitable for three or four wire system with the following features:
 - 1. Inputs: From sensors or current transformers from 100/5 through 5000/5 ratios and potential terminals up to 120VAC.
 - 2. Sampling: Digitally sampled current and voltage signals at a rate high enough to provide accurate RMS sensing and valid data for waveform analysis beyond the 30th harmonic (fundamental of 60 Hz).
 - 3. Memory: Of non-volatile type retained in the event of a control power interruption capable of storing the following:
 - a. Set-up parameters.
 - b. Instantaneous readings minimums and maximums.
 - c. Time and date of highest peak for all demand readings.
 - d. Three-phase voltage and current samples consisting of minimum 256 data points each representing at least four cycles of each waveform (stored upon user initiated command).
 - 4. Monitored Values: Appropriate for points as scheduled on Drawings with indicated accuracy.
 - 5. Equipment monitoring units may also be in the form of PLCs with zone selective interlocking (ZSI) and arc flash protection systems.

6. Reporting: Shall communicate with associated Individual Load Display Unit or Assembly Display Unit[**and future network**] by means of an RS-485 serial communication port built into the Load/Equipment Monitor.

2.7 INTEGRAL BREAKER MONITOR UNITS

- A. The integral breaker monitor shall be identical to the load/equipment monitor except shall optionally receive inputs from compatible solid-state breaker sensors. If compatibility is not possible, provide external sensors, PTs, and CTs as appropriate.

2.8 INDIVIDUAL LOAD DISPLAY UNIT

- A. The Individual Load Display Unit shall provide for operator interface with the load/equipment or integral solid-state breaker monitor (may be installed in one unit) at a specific unitized device.
 1. Access: To specific monitor.
 2. Readout: LED 6 digit (minimum) display.
 3. Logic: Microprocessor based with on board clock/calendar.
 4. Power: 120VAC.
 5. Keypad: Touch membrane keypad to provide local access to metered quantities via single keystroke advancing through the various display pages.
 6. Displayed Values: As scheduled on Drawings.
 7. Communication/Reporting: **[Extension of load/equipment monitor] [IEEE 802.11 Wireless Ethernet over dedicated 900 MHz spread spectrum].**

2.9 ASSEMBLY DISPLAY UNIT

- A. The Assembly Display Unit shall provide for operator interface with load/equipment and integral solid-state breaker monitors at an assembly (i.e., switchboard, switchgear, motor control center, etc.) and shall allow for individual monitored value review. Provide quantity of assembly display units to adequately monitor assembly device monitors.
 1. Access: To any monitor within the assembly.
 2. Readout: 4 line by 20-character minimum, high contrast LCD technology with adjustable backlighting to provide high reliability and superior readability in all light conditions.
 3. Logic: Microprocessor based with on board clock/calendar.
 4. Power: 120VAC.
 5. Keypad: Touch membrane keypad to provide access to metered quantities via single keystroke advancing through the various display pages.
 6. Displayed Values: As scheduled on Drawings.
 7. Communication/Reporting: Shall communicate with load/equipment monitors and integral solid-state breaker monitors with network by means of RS-485 serial communications.

2.10 EPMS SERVER

- A. Provide a PC based **[rack mounted]** server for automatic control of Electrical Power Management System operations. The server shall communicate with assembly display units, individual load display units, integral breaker monitor units, and load/equipment monitor units on the communications network to obtain the Power Monitoring data. The server will include ladder diagrams which will direct the automatic control operations for data collection and retrieval. The server shall include processor, input, output, and network interface units as required to implement the sensing, control, and remote communications with personal computer units and printers.
- B. Include UL listed surge protective device with 150 percent VA rating of initially connected equipment.
- C. **[UPS for a minimum of 6 hours of operation of server.]**

2.11 REDUNDANT CENTRAL COMPUTER

- A. Redundant Central Computer: Connected in a hot standby, peer configuration; automatically maintains copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real-time. If central computer fails, redundant computer shall assume control immediately and automatically.
 - 1. Configuration shall be server based.

2.12 METERING AND MONITORING SOFTWARE

- A. Operates in a multi-user multi-tasking environment using the latest version of Microsoft Windows.
- B. Password Protection: Three minimum configurable security levels.
- C. Online Help: Context sensitive.
- D. Coordinates the communications of the network.
- E. Provides interactive color graphics platform with mouse accessed menu and mouse driven generation of distribution system graphics, including the following:
 - 1. Site plan.
 - 2. Floor plans.
 - 3. Equipment elevations.
 - 4. Single line diagram.
- F. Provides mouse driven interface with devices depicted in single line diagram and equipment elevation screens.
- G. Logs user defined power monitoring and control and power distribution system events including log on/off; attempted log on/off; alarms; equipment operations; and out-of-limit, pickup, trip, and no response events; with date and time stamps accurate to 0.1 second.
- H. Exports and imports data to and from commonly used Microsoft Windows Excel spreadsheet, database, , and other applications; uses dynamic data exchange technology.
- I. Reports Trends: Instantaneously, in a real time or historical tabular format, bar chart, or user-defined time, trend plots of monitored parameters; unlimited as to interval, duration, or quantity of trends.
- J. Manages Alarm Function: Annunciates, logs, and prints alarm messages from discrete input and controls outputs, according to programmable security access protocol using the communication network.
 - 1. Functions Requiring User Acknowledgment: Run in background during computer use for other applications and override other presentations when they occur.
- K. Views and analyzes captured waveforms. Displays harmonic content through the twenty-first harmonic, minimum, and reports total harmonic distortion.
- L. Internal Load Consumption Demand Response: Defines and initiates load shedding schemes manually responding to programmable time schedules, or set points of metered demands, or combinations of both.
- M. Electric Utility Company Rate Demand Response: Defines and initiates loading parameters schemes manually responding to **[electric utility company rate structure] [real time pricing signals from the electric utility company] [programmable time schedules, or set points of metered demands, or a combination of both] [and] [alternative on site generator source operation]** to reduce operating costs.

- N. Communicates with BAS main workstation PC.
- O. Asset and Inventory Bar Code Software: Custom software to identify bar code labels in Division 26 Section "Electrical Identification" to tabulate and record pertinent device and device testing data and allow data upgrade per Owner requirements. Include pdf link to approved device shop drawing.

2.13 COMMUNICATION COMPONENTS AND NETWORK REQUIREMENTS

- A. Network Configuration: High speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet and BACnet TCP/IP protocol.
- B. Monitoring and Control System: Include server based workstation[**with graphics capability and Web access**], with its operating system and application software, connected to data transmission network.
- C. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
 - 1. Minimum Protection for Power Lines 120V and More: Auxiliary panel suppressors complying with requirements of IEEE C37 90.
 - 2. Minimum Protection for Communication, Signal, Control, and Low Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.
- D. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring [**and control**] clients.
- E. BAS Interface: Provide factory installed hardware and software to enable the BAS to monitor, display, and record data for use in processing reports.
 - 1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor.
 - 2. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely monitor meter information from a BAS operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS.

2.14 MONITOR AND CONTROL GROUPS READINGS

- A. Scheduled Monitor / Control Groups shall depict the following minimum display values:
 - 1. Load Monitoring: Instantaneous Readings:
 - a. Apparent power, 3 phase total (KVA).
 - b. Current, apparent RMS (Amps).
 - c. Current, per phase RMS (Amps).
 - d. Frequency (Hertz).
 - e. Power factor, per phase.
 - f. Power factor, 3 phase total.
 - g. Reactive power, 3 phase total (KVAR).
 - h. Real Power, 3 phase total (KW).
 - i. Voltage, phases (Volts).
 - j. Voltage, phases to phases (Volts).
 - k. Demand Readings:
 - 1) Average demand current, per phase (Amps).

- 2) Peak demand current, per phase (Amps).
 - 3) Average demand, real power (KW).
 - 4) Predicted demand, real power (KW).
 - 5) Peak demand, real power (KW).
 - I. Energy Readings:
 - 1) Accumulated energy (KWH).
 - 2) Accumulated reactive energy (KVARH).
 2. Load Monitoring: Waveform Capture:
 - a. Voltage, phases.
 - b. Current, phases.
 - c. Residual neutral current.
 3. Load Monitoring: Harmonic Measurements (for three phase and single phase):
 - a. Total harmonic distortion (THD).
 - b. RMS magnitudes, voltage and current (Volts, Amps).
 - c. Peak Values (THD, Volts, Amps).
 - d. Crest factors.
 - e. Magnitudes of the individual harmonics (Volts, Amps).
 - f. Telephone Interference factor (TIF).
 4. Load Monitoring: Demand Point Alarm:
 - a. Preset per Owner request.
 5. Device Position: Open / Closed.
 6. Device Position: Normal / Emergency.
 7. Device Position: Normal / Emergency / Bypass to Normal / Bypass to Emergency.
 8. Temperature: Fans On / Fans Off.
 9. Time: Time of Day.
 10. Generator Status: Generator Running / Emergency Mode.
 11. Generator Control: Peak Shave Start / Peak Shave Shutdown.
 12. ATS Control: Normal Mode / Peak Shave Mode.
 13. Device Status: Alarm(s).
 14. Provide the ability to instantaneous back-trend historical information (parameters listed above) for up to a year.
 15. Surge Protection Device (SPD) breaker is not to be considered a branch breaker of the assembly for monitoring purposes. Only SPD status alarms are to be monitored as scheduled on Drawings.
- 2.15 COMMUNICATION FEATURES OF POWER DISTRIBUTION SYSTEM DEVICES
- A. Communication Function: Server based and integral to devices indicated as having power monitoring or control functions.
 1. Communication Address: Unique to each individual device, and changeable at device.
 2. Communication Protocol: Match that of network to which connected.
 3. Two-Way Communication: Send and receive values, data, and control commands indicated. Initiate alarm on malfunction of monitored device of monitoring equipment or network.
 - B. Circuit Breakers, 600V and Less: Include communication capability as a feature of the trip unit.
 - C. Medium-Voltage Circuit Breakers: Include communication capability as a feature of the overcurrent relay trip unit.

- D. Motor Controllers, 600V and Less: Include communication capability as a feature of the motor protection relay, or in a network interface card designed to mount on the controller.
- E. Multifunction Digital Meter and Power Quality Monitor: Microprocessor-based device, flush or semi-flush mounted in the door of switchboard or switchgear. Unit shall display and communicate indicated monitoring parameters and data for circuit and inputs to which connected. Unit shall have the ability to communicate as specified in "Communication Function" paragraph above plus the following:
 - 1. Waveform data from high-speed sampling of voltage and current values metered.
 - 2. Status of up to three external contact-monitored alarm conditions monitored by internal meter relay functions.
 - 3. Monitoring of a minimum of three programmable threshold values of metered parameters.
- F. Addressable Monitoring Relay: Continuously polled for data, via the communication network, as to the state (open or closed) of dry contacts of a contact-making sensing device.
 - 1. Ability to Communicate: As specified in "Communication Function" paragraph above.
 - 2. Power Supply Rating: 120VAC or 48 to 125VDC.
 - 3. Enclosure: NEMA 250, Type 12, unless otherwise indicated.
- G. Addressable Control Relay: Capable of being controlled from central-processing workstation to operate from form C dry contacts to provide on/off control of an independent circuit or device.
 - 1. Ability to Communicate: As specified in "Communication Function" paragraph above.
 - 2. Monitors status, on/off status of controlled contacts.
 - 3. Power Supply Rating: 120VAC or 48 to 125VDC.
 - 4. Enclosure: NEMA 250, Type 12, unless otherwise indicated.
 - 5. Contact Ratings: Make 40 A, minimum; break 7 A, minimum.
- H. Accuracy of Devices:
 - 1. Comply with ANSI C12.20, Class 0.5; and IEC 62052-11 and 62053-22, Class 0.5 for revenue grade meters.
 - 2. Accuracy from Light to Full Rating:
 - a. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
 - b. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
 - c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
 - d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.

2.16 LOW VOLTAGE WIRING

- A. Data Line Cable: Shielded, twisted-pair cable or other media recommended by manufacturer and as specified in **[Division 26 Section "Control Voltage Electrical Power Conductors and Cables."]** **[Division 27 Section "Structured Telecommunication Cabling Systems."]**
- B. LAN RS-485 Cables: Comply with **[Division 26 Section "Control Voltage Electrical Power Conductors and Cables."]** **[Division 27 Section "Structured Telecommunication Cabling Systems."]**
 - 1. PVC Jacketed, RS-485 Cable: Paired, two pairs twisted, No. 22 AWG, stranded (7 x 30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
 - 2. Plenum Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7 x 30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.

3. Unshielded Twisted Pair Cables: Category [5e] [6] as specified for horizontal cable for data service in [Division 26 Section "Control Voltage Electrical Power Conductors and Cables."] [Division 27 Section "Structured Telecommunications Cabling Systems."]

C. RS-232 Cable:

1. PVC Jacketed, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - a. Type CM.
 - b. Flame Resistance: UL 1581, vertical tray.
2. Plenum Type, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - a. Type CMP.
 - b. Flame Resistance: NFPA 262, flame test.

D. Low Voltage Control Cable: Multiple conductor, color coded, No. 20 AWG copper, minimum.

1. Sheath: PVC; except in plenum type spaces, use sheath listed for plenums.
2. Ordinary Switching Circuits: Three conductors, unless otherwise indicated.
3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

2.17 ACCESSORIES

- A. Interfaces with Distribution Equipment Specified in Other Sections: Accessories, adapters, electronic interface units, and connections required for functional performance indicated.

PART 3 - EXECUTION – NOT USED

END OF SECTION 260913

SECTION 260944 - LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Comply with the latest version of Title 24, part 6 Energy Code.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Network equipment, software, modules, controllers, and devices:
 - a. Acuity – N-Light System.
 - b. Crestron – Green Light System.
 - c. Legrand Wattstopper – DLM System.
 - d. Lutron – Quantum System.
 2. Emergency Lighting Control Modules:
 - a. Bodine.
 - b. LVSS.
 - c. Legrand.
 - d. Acuity.
 - e. Lutron.

2.2 NETWORK EQUIPMENT

- A. Control Software:
1. Provide Windows® based operating software to provide a graphical user interface for system programming, monitoring, and control functions, from a remote, Owner provided, microcomputer.
 2. The software provided shall allow for not less than the following features and functions:
 - a. Program each zone installed for its designated on/off time, time delay override period, if any, blink warning, manual override input device, and other control device inputs.
 - b. View the status of each device in the system.
 - c. Allow administrators the ability to create password protected security settings to operate the software and its various generated screens, reports, etc.
 - d. Allow administrators the ability to create custom reports or use pre-programmed report templates.
 - e. Provide control schedules by controller or group - daily, weekly, or school calendar based.
 - f. Provide Windows® based point and click style interface for making programming changes, text inputs, data input, etc.
 - g. Provide floor plan views of the building, showing individual rooms or groups of rooms, and their assigned controllers, schedules, and status.
 - h. Provide on-screen simulation of system operation.
 - i. Support BMP, WMF, JPEG, AVI, PCX, and DCX graphics file formats.
 3. Acceptable Manufacturers:
 - 1) Acuity – nLight Sensor View.

- 2) Legrand – Supervisor Software Suite.
- 3) Lutron – Quantum Total Lighting Management Suite.

B. Network Gateway:

1. Solid state, microprocessor based, electronic device that provide for, and stores, real time-based scheduling and programming of devices connected to the network, as well as providing an interface to the building LAN, BAS, or remote PC.
2. Provides a gateway for loading and retrieving system software to and from remote LAN, BAS, or standalone PCs, for the purpose of programming, monitoring, and performing diagnostic and troubleshooting functions of the digital lighting control system/network devices and components.
3. Connects other digital lighting control components, as a floor, space, or area network node, provided with modular IN/OUT network cable terminations for field connection to other digital control equipment/networked devices and components.
4. Control voltage, Class 2 (15-28VDC) operating device.
5. Provided with surface wall sheet metal enclosure or mounting rack for field installation of network control modules.
 - a. Integral 120VAC to 15-28VDC power supply to power network devices.
 - b. Integral 120VAC duplex receptacle.
6. Warranted against material, workmanship, and operational defects, for not less than five (5) years.
7. Acceptable Manufacturers:
 - a. Acuity – nLight Eclipse.
 - b. Legrand – BCS-WS-CS-LMJA Series.
 - c. Lutron – Quantum Total Lighting Management Suite.

C. Network Bridge:

1. Solid state, electronic device that provides a networked communications interface between floor, space, or area digital lighting control equipment devices, and provides for the expansion and growth of the system/network.
2. Provides for small, local, room by room connected devices to be interconnected into a much larger area, zone, or building wide network, all communicating together over the same digital lighting control network.
3. Connects to other digital lighting control components, as a network node, provided with modular IN/OUT network cable terminations, for field connection to other digital control equipment/ networked devices and components.
4. Control voltage, Class 2 (24VDC) operating devices, powered by, and from, remote adjacent networked devices, or from a dedicated, remote, 120VAC power supply.
5. Connects to BAS and LAN servers.
6. Warranted against material, workmanship, and operational defects, for not less than five (5) years.
7. Acceptable Manufacturers:
 - a. Acuity – nLight Bridge NBRG8.
 - b. Legrand – LMBC-300 Series.
 - c. Lutron – Quantum Light Management Hub (QP3).

2.3 POWER OVER ETHERNET SWITCH (PoE) 10/100

- A. Provide high-quality switch for the deployments of converged applications. The switch shall take advantage of high-density Gigabit Ethernet deployments. Switches shall provide support for:
1. 10 / 100 auto sensing stackable Ethernet switch with 24 powered ports.
 2. 802.1Q trunking and 802.1p for proper treatment of Layer 3.
 3. Multiple egress queues to provide priority queuing of RTP voice packet streams.

4. Automated QoS configuration in VoIP networks that detects IP phone devices, classifies traffic, and helps enable egress queue configuration.
5. Must comply with the 802.3af Power over Ethernet standard.
6. Provide adjustable power management on a per port basis.
7. Provide two Gigabit copper uplink GBICs for connection to Core switch.
8. Support the following standards: 802.1s, 802.1w, 802.1x, 802.3ad, and 802.1D spanning tree protocol.
9. Auto configuration of new stack units. DHCP auto configuration of multiple switches.
10. Switches will be managed from a single platform that will also manage the Core Switch and the Router.
11. 72 Mbps forwarding rate.
12. 160 Gbps Switch Architecture.

B. Basis for Design: Cisco 3850, or equivalent Campus standard product.

2.4 EQUIPMENT RACKS

- A. 19 inch, free standing, 2 post, or vertical wall mount style.
- B. Refer to Division 27 Section "Communications Cabinets and Racks."

2.5 AC POWER STRIPS

- A. Designed for field installation in standard 19 inch, EIA/TIA equipment rack.
- B. Surge suppression type, with automatic recovery after surge event, with visual diagnostic indicators identifying the type of event that triggered the protection.
- C. Rated 20A at 120VAC, 60 Hz, provided with integral thermal overload protection and resettable circuit breaker.
- D. Provided with factory installed 3-wire cord and plug.
- E. Provided with not less than four (4) duplex receptacles factory installed at rear of unit, and one simplex receptacle installed on face of unit.
- F. Basis for Design: Middle Atlantic Products – PD 920R-SP, or equivalent, supplied by addressable, networked low voltage equipment manufacturer/supplier.

2.6 NON-SYSTEM COMPONENTS

- A. Electronic and Dimming Drivers:
 1. Compatible with addressable lighting control equipment, and as specified in Division 26 Section "Interior Lighting."
- B. Shade Controls:
 1. Compatible with addressable lighting control equipment, and as specified in other Divisions.

2.7 CONDUCTORS AND CABLES

- A. Wiring to Line Voltage Side of Power Sources and Devices: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

- B. Network Interconnect Cable: For field interconnection of the lighting control equipment's peripheral networked devices, automatic sensors, switches, dimmers, etc., providing the digital control functions and operations specified.
1. Provide both low voltage power and communications data to interconnected devices and components **through the building data network**.
 2. Specifications:
 - a. Manufacturer specific, multi-conductor, jacketed cable with copper conductors as directed by the equipment manufacturer.
 - b. Provide pre-terminated and unterminated cables as directed by the equipment manufacturer.
 - c. NFPA 262 (UL: FT6, CSA: CMP) Flame rated jacket and conductor insulation for plenum use.

PART 3 - EXECUTION – NOT USED

END OF SECTION 260944

SECTION 261230 - MEDIUM VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Preference is for all electrical distribution equipment to be installed indoors. If outdoor MV transformer is required due to space constraints, enclose in yard, caged top, with locked door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Basis for Design:
 - a. GE Industrial Solutions; a member of ABB Group.
 - b. Square D; Schneider Electric.
- 2. Acceptable equivalents:
 - a. Hammond is Canadian.
 - b. ABB Group; ABB Power System Division.
 - c. Cooper Industries; Cooper Power Systems Division.
 - d. Cutler-Hammer.
 - e. Hammond Manufacturing Transformer Group.
 - f. Howard Industries, Inc.
 - g. Siemens Energy & Automation, Inc.

2.2 REGULATORY REQUIREMENTS

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Division 01 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. Comply with IEEE C2.
- D. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.
- E. Comply with NFPA 70 and NFPA 70E.

2.3 SEISMIC PERFORMANCE

- A. Seismic Performance: Medium voltage transformers shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 TRANSFORMERS, GENERAL

- A. Medium-Voltage Transformers: Factory assembled and tested, general purpose, air cooled, and forced air cooled, dry type or liquid filled as indicated, and having characteristics and capacities as indicated.
- B. Windings: 2-winding type, designed for operation with high voltage windings connected to a 3-phase, 3-wire, 60 Hz, grounded neutral system.
- C. Sound Level: Sound level of transformers without fans for this project shall be a minimum of 3 dB less than NEMA TR 1 standard sound levels for transformer type and size indicated when factory tested in accordance with applicable ANSI standard. Audible sound-level tests shall be added to routine factory tests performed on transformers for this project.
- D. Coordinate with drawings for fan power source. Provide 120V circuit.
- E. Forced air cooled transformers shall comply with the following requirements:
 - 1. Forced-air-cooling equipment shall consist of cooling fans, temperature sensing devices, and controls complete with housing, mounting devices, and wiring. Operation of cooling fans shall be automatically and sequentially controlled by temperature sensing devices. A manually operable switch shall be connected in parallel with the automatic control contacts. Controls shall be enclosed in a cabinet located on the side of the transformer 60 inches or less above the base.
 - 2. Cooling Fans: Propeller type, with steel blades and TEFC motors, direct drive. Motor circuits shall be individually fused or thermally protected. Fans shall have OSHA fan guards if not installed within transformer enclosure.
 - 3. Fan Control: Thermally operated winding temperature control devices.
 - 4. Fan cooling shall increase the KVA rating a minimum of 33-1/3 percent of base rating.
- F. Provisions for Future Forced Air Cooling: Include the following provisions where future forced-air cooling is required:
 - 1. Top Liquid Temperature Sensing on Liquid Filled Transformers: Thermally operated control device with thermal element mounted in a well, and provisions for mounting the control cabinet, the conduit, and the fans.
 - 2. Winding Temperature Sensing on Liquid Filled Transformers: Thermally operated winding temperature control device with thermal element mounted in a well, a heating coil, and provisions for mounting the control cabinet, conduit, and fans.
 - 3. Winding Temperature Sensing on Dry Type Transformers: Insulated wells in all three coils for the future installation of sensors directly in the air ducts of each coil to monitor coil temperature, and provisions for future mounting of cooling fans, control cabinet, and conduit.
- G. Windings: Copper.
- H. Minimum Efficiency: Per US DOE test procedure 10 CFR Part 431, Sub-part K, Appendix A at 50 percent of nameplate-rated load.

2.5 LIQUID FILLED TRANSFORMERS

- A. Description: IEEE C57.12.00 and UL 1062, liquid filled, 2-winding transformers.
- B. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.
- C. Insulating Liquid: Less flammable, seed oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

- D. Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- E. Insulating Liquid: Less flammable, silicone based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.
- F. Insulation Temperature Rise: 65 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.
- G. Basic Impulse Level: Comply with UL 1062.
- H. Basic Impulse Level: **[60] [75] [95] [110]** kV.
- I. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- J. Cooling System: Class **[ONAN, self-cooled] [ONAN/ONAF, self-cooled, and with forced-air-cooled rating] [ONAN/FONAF, self-cooled, and with provisions for future forced-air-cooled rating]**. Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.
- K. Sound level may not exceed **sound levels listed in NEMA TR 1.** , without fans operating. Provide low audible sound level option.
- L. Impedance: **<Insert value>** percent.
- M. Magnetizing Inrush Characteristics: Comply with IEEE 242 Standard not to exceed 12 times transformer full load primary current.
- N. Minimum Efficiency at 50 Percent Load:

3-Phase KVA	Efficiency %
500	99.25
750	99.32
1000	99.36
1500	99.42
2000	99.46
2500	99.49
3000	99.17

- O. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
 - 1. Liquid-level gage.
 - 2. Pressure-vacuum gage.
 - 3. Liquid temperature indicator.
 - 4. Drain and filter valves.
 - 5. Pressure relief device.

2.6 DRY TYPE TRANSFORMERS

- A. Description: NEMA ST 20, IEEE C57.12.01, **[ANSI C57.12.50] [ANSI C57.12.51] [ANSI C57.12.52], [UL 1562 listed and labeled]**, dry type, 2-winding transformers.
1. **[Indoor, ventilated] [Outdoor, ventilated] [Totally enclosed, nonventilated]**, vacuum pressure impregnated and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
 2. **[Indoor, ventilated] [Outdoor, ventilated] [Totally enclosed, nonventilated]**, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
- B. Primary Connection: Air terminal compartment with removable door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.
- C. Secondary Connection: Air terminal compartment with removable] door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.
- D. Insulation Materials: IEEE C57.12.01, rated at 220 deg C.
- E. Insulation Temperature Rise: **[80] [115]** deg C maximum rise above 40 deg C.
- F. Basic Impulse Level: **[60] [75] [95] [110]** kV.
- G. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.
- H. Cooling System: Class **[AA, self-cooled] [AA/FA, self-cooled, and with forced-air-cooled rating] [AA/FFA, self-cooled, and with provisions for future forced-air-cooled rating]**, complying with IEEE C57.12.01.
1. Automatic forced air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current limiting fuses, indicating lights, alarm, and alarm silencing relay.
 2. Include mounting provision for fans.
- I. Impedance: **<Insert value>** percent.
- J. Magnetizing Inrush Characteristics: Comply with IEEE 242 Standard not to exceed 12 times transformer full load primary current.
- K. Minimum Efficiency at 50 Percent Load:

3-Phase KVA	BIL	Efficiency %
500	20-45	98.96
500	46-95	98.83
750	20-45	99.07
750	46-95	98.95
1000	20-45	99.14
1000	46-95	99.03
1500	20-45	99.22
1500	46-95	99.12
2000	20-45	99.27
2000	46-95	99.18
2500	20-45	99.31
2500	46-95	99.23
3000	20-45	99.10

MEDIUM VOLTAGE TRANSFORMERS

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3-Phase KVA	BIL	Efficiency %
3000	46-75	99.10

- L. High Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

2.7 PAD-MOUNTED, LIQUID FILLED TRANSFORMERS

- A. Description: ANSI C57.12.13, [**ANSI C57.12.26**,]IEEE C57.12.00,[**IEEE C57.12.22**,] pad-mounted, 2-winding transformers. Stainless-steel tank base [**and cabinet**] [, **cabinet, and sills**].
- B. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.
- C. Insulating Liquid: Less flammable, seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- D. Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- E. Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.
- F. Insulation Temperature Rise: **[55] [65]** deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.
- G. Basic Impulse Level: **[30] [60] [95]** kV.
- H. Minimum Efficiencies for 3-Phase Application at 50 Percent Load:

KVA	Efficiency %
500	99.1
750	99.2
1000	99.2
1500	99.3
2000	99.4
2500	99.4

- I. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- J. Impedance: **<Insert value>** percent.
- K. Magnetizing Inrush Characteristics: Comply with IEEE 242 Standard not to exceed 12 times transformer full load primary current.
- L. High-Voltage Switch: **[200] [300] [400]** A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
- M. High Voltage Terminals: Arranged for radial feed, with 3-phase, 2-position, gang-operated load-break switch, oil immersed in transformer tank, with hook-stick-operated handle in the primary compartment.

MEDIUM VOLTAGE TRANSFORMERS

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- N. High-Voltage Terminals: Arranged for loop feed with 3-phase, 4- position, gang-operated load-break switch, oil immersed in transformer tank, with hook-stick-operated handle in the primary compartment.
- O. High-Voltage Switch: **[200] [300] [400]** A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for loop feed with 3-phase, 4-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
- P. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. **[Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.]**
 - 1. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
- Q. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have **[three arresters for radial-feed] [three arresters for loop-feed] [six arresters for loop-feed]** circuits.
- R. High-Voltage Terminations and Equipment: Live front with externally clamped porcelain bushings and cable connectors suitable for terminating primary cable.
- S. High-Voltage Terminations and Equipment: Dead front with universal bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
 - 1. Bushing-Well Inserts: One for each high-voltage bushing well.
 - 2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
 - 3. Parking Stands: One for each high-voltage bushing well.
 - 4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.
- T. High-Voltage Terminations and Equipment: Dead front with dead break integrated bushing and elbow, complying with ANSI/IEEE 386.
- U. Accessories:
 - 1. Drain Valve: 1 inch (25 mm), with sampling device.
 - 2. Dial-type thermometer.
 - 3. Liquid-level gage.
 - 4. Pressure-vacuum gage.
 - 5. Pressure Relief Device: Self-sealing with an indicator.
 - 6. Mounting provisions for low-voltage current transformers.
 - 7. Mounting provisions for low-voltage potential transformers.
 - 8. Busway terminal connection at low-voltage compartment.
 - 9. Alarm contacts for gages and thermometer listed above.
 - 10. Key interlocks on HV compartment duct.

2.8 IDENTIFICATION DEVICES

- A. Per Division 26 Section "Electrical Identification."

2.9 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to **[ANSI C57.12.50] [ANSI C57.12.51] [IEEE C57.12.90] [IEEE C57.12.91]**.

- B. Factory Tests: Perform the following factory-certified tests on each transformer:
1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
 2. Ratios on rated-voltage connection and on tap extreme connections.
 3. Polarity and phase relation on rated-voltage connection.
 4. No-load loss at rated voltage on rated-voltage connection.
 5. Excitation current at rated voltage on rated-voltage connection.
 6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
 7. Applied potential.
 8. Induced potential.
 9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.
 - a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.
 10. Owner and Engineer witness all required factory tests. Notify **[Construction Manager]** **[Owner]** at least 14 days before date of tests and indicate their approximate duration. Include an allowance to include travel, meals, and accommodations for two representatives for factory testing procedure.

PART 3 - EXECUTION – NOT USED

END OF SECTION 261230

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SECTION 261300 - MEDIUM VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

- A. Preference is for all electrical distribution equipment to be installed indoors. If outdoor MV Switchgear is required due to space constraints, enclose in yard, caged top, with locked door.
- B. Gear key shall be standardized to match existing locks across campus.

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 REGULATORY REQUIREMENTS

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Assembly Selection: The drawings indicate sizes, profiles and dimensional requirements of assembly equipment. Equipment having equal performance characteristics and complying with indicated maximum dimensions and profiles may be considered, provided deviations do not change the design concept intended performance or code/future extension provision clearances. The burden of proof of equality is on the proposer a minimum of 10 days prior to bid.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.
- D. Comply with IEEE C2.

2.3 SEISMIC PERFORMANCE

- A. Seismic Performance: Medium voltage switchgear shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 MEDIUM VOLTAGE SWITCHGEAR, GENERAL REQUIREMENTS

- A. General: Factory assembled, factory tested, with functions and circuit assignments for each bay and types, characteristics, and ratings of busses and disconnecting, and protective devices as indicated. Switchgear shall conform to NEMA Standard SG5, "Power Switchgear Assemblies."
- B. Description: Factory assembled and tested and complying with IEEE C37.20.1.
- C. Ratings: Suitable for application in 3 phase, 60 Hz, solidly grounded neutral system.

- D. System Voltage: **[4.16 kV nominal; 4.76 kV maximum] [7.2 kV nominal; 15 kV maximum] [13.8 kV nominal; 15 kV maximum] [34.5 kV nominal; 38 kV maximum] <Insert other voltage>**.

2.5 METAL ENCLOSED INTERRUPTER SWITCHGEAR

- A. Basis of Design Manufacturers:
1. GE Industrial Solutions; a member of ABB Group.
 2. Square D; Schneider Electric.
- B. Acceptable Manufactueres:
1. ABB Group, ABB Power Systems Division.
 2. Eaton Corporation; Cutler-Hammer Products.
 3. JAGG Electrical and Control.
 4. Industrial Electric Mfg. (IEM).
 5. S&C Electric Company.
 6. Siemens Energy & Automation, Inc.
- C. Comply with IEEE C37.20.3.
- D. Comply with IEEE C37.20.7. Provide arc resistant switchgear, Type **[2B] [2C]**.
- E. Design Level of Available Source Fault Current: Integrated short circuit rating consistent with value of fault current indicated.
- F. Ratings: Comply with standard ratings designated in IEEE C37.20.3 for maximum rated voltage specified.
1. Main Bus Rating: **[600] [1200] [2000]** A, continuous.
- G. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.
1. Rating: **[600] [1200]** A continuous duty and load break.
 2. Duty Cycle, Fault Closing: **[25,000] [40,000]** asymmetrical A.
 3. Switch Action: No external arc and no significant quantities of ionized gas released into the enclosure.
 4. Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored energy operating mechanism.
 5. Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
 6. Protective Shields: Cover live components and terminals.
 7. Fuses: De-energized if switch is open.
- H. Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.
- I. Window: Permit viewing switchblade positions if door is closed.
- J. Infrared (IR) View Panes: IR transmittance lens secured and sealed to assembly enclosure to allow inspection of electrical transmission components without elevated levels of Personal Protective Equipment (PPE). Locate view panels on **[front] [and] [back]** of enclosure to allow use of cameras with 2x to 3x horizontal and 1.5x to 2x vertical distance to target with a maximum angle of incidence of 30 degrees to view all 70 volt cable, busbar, and protective device connections within the assembly. Label each window by number, instructions for use, lens material, window transmission rates, and target components; location by clock face method; and baseline emissivity (e.g., Busbar Connection: 2 o'clock: E = 0.95").

- K. Power Fuses: Comply with the following and with applicable requirements in NEMA SG 2:
 - 1. Indicator: Integral with each fuse to indicate when it has blown.
 - 2. Mounting: Positively held in position with provision for easy removal and replacement from front without special tools.
 - 3. Current Limiting Fuses: Full range, fast replaceable, current limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
 - 4. Expulsion Fuses: Furnished in disconnect type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.
- L. For arc resistant switchgear, provide a barrier between the load break switch compartment which accessing the fuse compartment after the switch has been locked open.

2.6 COMPACT 5.5 KV LOAD INTERRUPTER SWITCHES

- A. Manufacturers:
 - 1. ROMAC, A Division of Power Controls, Inc.
 - 2. Square D Co. "Minibreak" Series.
- B. General: Stationary mounted in switchgear and including the following features:
 - 1. Arrangement and Rating: Gang operated, rated 200 amperes for continuous duty and for load break. Suitable for operation up to the maximum short circuit rating of the integrated switchgear assembly.
 - 2. Dead front assembly with no rear access.
 - 3. Switch Action: No external arc. Interrupting action shall not liberate significant quantities of ionized gas into the enclosure.
 - 4. Switch Construction: Switch blade material shall be copper. Switch and all associated parts including electrical and mechanical connections shall be supported entirely from the interior framework of the structure. Switch shall have external manual operating handle with lock open padlocking provisions for multiple padlocks.
 - 5. Operating Mechanism: Quick make, quick break, stored energy type.
 - 6. Barriers: Phase barriers for the full length of the blades and fuses for each pole. If a protective barrier is used, it shall be designed for easy removal. The barrier material shall allow visual inspection of the switch with the barrier in place.
 - 7. Protective shield to cover potentially live parts and terminals.
 - 8. Fuses: De-energized when switch is open.
 - 9. Mechanical interlock shall prevent opening the door unless the switch blades are open and closing the switch if the door is open.
 - 10. Window: For viewing switch blade positions.
 - 11. Duty Cycle Fault Closing Rating: 12,500 amperes rms asymmetrical.
 - 12. Duty Cycle Fault Closing Rating: 20,000 amperes rms asymmetrical.
- C. Power Fuses: Current limiting ratings as indicated. Each fuse shall have an indicator to show it has blown. Fuses shall meet applicable requirements of NEMA Standard SG 2, "High Voltage Fuses," and the following:
 - 1. Fuses shall be positively held in position with provision for easy removal and replacement from the front without the use of special tools.
 - 2. Spares: Each fusible bay shall include three fuses in use and three spare fuses in storage clips. Provide hold down clips to prevent fuses from accidentally or seismically loose within the bay.
- D. Current Limiting Fuses: Fuses shall be of the full range, fast replaceable, current limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from the tube.

- E. Interrupting rating of fuses at rated system voltage shall be as indicated.

2.7 MEDIUM VOLTAGE TRANSFER SWITCHGEAR

- A. Manufacturers shall match associated metal clad switchgear manufacturers.
- B. Comply with NEMA, ANSI/IEEE C37.20.3 and C37.04, NFPA 70, and NFPA 70E.
- C. Ratings:
 - 1. Voltage: 4.16 KV nominal, 4.76 KV maximum.
 - 2. Current: 1200 amperes.
 - 3. BIL: 60 KV.
 - 4. Short Circuit Withstand and Integrated Short Circuit Rating: 350 MVA.
 - 5. Nominal Interrupting Class: 350 MVA.
- D. Control Power Supply: DC battery system.
- E. Related Documents:
 - 1. The medium voltage transfer switchgear shall comply with all requirements of Paragraph "Metal Clad Vacuum Circuit Breaker Switchgear" and "Central Battery System."
 - 2. The medium voltage transfer switchgear shall comply with requirements of Division 26 Section "Paralleling Switchgear."
- F. Transfer Switchgear Function:
 - 1. The medium voltage transfer switchgear shall provide all the functionality of a medium voltage automatic transfer switch, utilizing vacuum circuit breakers and electronic relays for control. The DPU (Distribution Protection Unit) electronic relay packages shall provide control monitoring, and protection for the closed transition transfer switching event. The transfer switchgear controls shall provide generator for start signal and remote status indications to the generator control system and paralleling switchgear.
 - 2. The transfer switchgear shall include voltage and current transformers, vacuum circuit breakers, electronic relay control packages, and all auxiliary components and controls for the automatic transfer switch operation.
 - 3. Emergency Power Mode: A loss of voltage on incoming normal source will be sensed and a generator start signal will be initiated to the generator control system (following standard open transition, automatic transfer switch operation). Transfer to the emergency source shall be provided upon proper voltage and frequency available at the transfer switchgear.
 - 4. Load Test Mode: Generator control system shall initiate a load test mode, and transfer switchgear shall operate as a closed transition transfer switch, with temporary paralleling of both sources for a maximum duration of 100 ms. This operation is intended to provide a seamless "soft transfer" function to avoid dropping of load during test.
 - 5. Coordinate with generator control system and paralleling switchgear and ATS manufacturers for optimum time delay settings.

2.8 METAL CLAD CIRCUIT BREAKER SWITCHGEAR

- A. Basis of Design Manufacturers:
 - 1. General Electric Distribution & Control.
 - 2. Square D; Schneider Electric.
- B. Acceptable Manufacturers:
 - 1. ABB Control, Inc.
 - 2. Eaton Corporation; Cutler-Hammer Products.
 - 3. JAGG Electrical & Control.
 - 4. Pedersen Power Products.

- 5. Siemens Energy & Automation, Inc.
- C. Comply with IEEE C37.20.3.
- D. Comply with IEEE C37.20.7. Provide arc resistant switchgear, Type **[1] [2] [1B] [2B] [1C] [2C]**.
- E. Nominal Interrupting Capacity Class: **[250] [350] [500] [750] [1000]** MVA.
- F. Ratings: Comply with IEEE C37.04.
 - 1. Main Bus Rating: **[1200] [2000] [3000]** A, continuous.
- G. Circuit Breakers: Three pole, single throw, electrically operated, drawout mounted units using three individual, vacuum sealed interrupter modules and including the following features:
 - 1. Designed to operate at rated voltage to interrupt fault current within its rating within **[three] [five]** cycles of trip initiation. For systems with X/R ratio of 17 or less, transient voltage during interruption shall not exceed twice the rated line-to-ground voltage of the system.
 - 2. Contact Wear Indicator: Readily accessible to field maintenance personnel.
 - 3. Minimum of six Type A and six Type B spare contacts.
 - 4. Interchangeability: Circuit breakers are interchangeable with vacuum circuit breakers of same current and interrupting ratings.
 - 5. Operating Mechanism: Electrically charged, mechanically and electrically trip free, stored energy operated.
 - a. Closing speed of moving contacts to be independent of both control and operator.
 - b. Design mechanism to permit manual charging and slow closing of contacts for inspection or adjustment.
 - 1) Control Power: **[48] [125] <Insert voltage>** V dc for closing and tripping.
 - 2) Control Power: **[120] [240] <Insert voltage>** V ac for closing and tripping.
 - c. Provide shunt trip capability independent of overcurrent trip.
- 6. **[Provisions for remote racking system.]**
- H. Test Accessories: Relay and meter test plugs.
- I. Arc Flash Protection System (AFPS): Assembly integrated microprocessor based system with the following features:
 - 1. Function:
 - a. Manually set assembly electronic relays to instantaneous trip "AFPS" mode with no time delay thus defeating system relay coordination to minimize arc flash incident energy. This theoretically allows assembly maintenance or troubleshooting to be more safely performed by qualified personnel with the assembly energized.
 - b. Manual reset to "normal" mode shall reset relay settings per coordination study. Assure backup electronic storage of normal protective device settings which can be automatically downloaded to relay.
 - 2. Manual AFPS-Normal Switch:
 - a. Dedicated switch located on front of each electronic overcurrent protection relay.
 - b. Local or remote indicator lights shall indicate operating modes.
 - 3. Rotating Beacon:
 - a. Mount rotating industrial grade amber beacon on top of each assembly to remind personnel that AFPS system is activated.
 - 4. Power Supply:
 - a. Manufacturer standard with control transformers integral to associated assembly.

5. Identification:
 - a. AFPS switch identification, switch AFPS and normal mode, and appropriate warning labels shall be engraved laminated acrylic or melamine label type as specified in Division 26 Section "Electrical Identification."
6. Remote Alarm Provision:
 - a. **[Integrated communication to Division 26 Section "Electric Power Management System."]**Light Sensing Arc Flash Protection System (LSAFPS): Assembly integrated microprocessor based system with the following features:
 1. Fiber optic arc flash light sensors to detect light produced by an arc flash event.
 - a. Point Sensor: To cover and trip specific breaker bus compartment.
 - b. Loop Sensor: To cover bus differential protection zone and provide entire switchgear lineup assembly and tripping of **[main] [all]** circuit breakers.
 2. Fast acting protection relay which receives light sensor event, verifies an overcurrent incident to prevent false tripping, then signals associated circuit breaker to trip.
 3. Current transformer to monitor breaker overcurrent incident.
 4. Remote Alarm Provision:
 - a. Two sets of normally open and normally closed contacts.
- K. Low DC Voltage Alarm: Switchgear shall have a monitor for dc control power voltage with a remote alarm located where indicated. Alarm shall sound if voltage falls to an adjustable value to indicate an impending battery failure. Factory set alarm value at 80 percent of full charge voltage.

2.9 FABRICATION

- A. Indoor Enclosure: Steel. <preference>
- B. Outdoor Enclosure: Galvanized steel, weatherproof construction; integral structural steel base frame with factory applied asphaltic undercoating.
 1. Each compartment shall have the following features:
 - a. Structural design and anchorage adequate to resist loads imposed by [125 mph (200 km/h)] wind.
 - b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
 - c. Louvers equipped with insect and rodent screen and filter and arranged to permit air circulation while excluding rodents and exterior dust.
 - d. Hinged front door with locking provisions.
 - e. Interior light with switch.
 - f. Weatherproof GFCI duplex receptacle.
 - g. Power for heaters, lights, and receptacles to be provided **[by control power transformer] [as indicated]**.
 2. Weatherproof internal aisle construction shall have the following features:
 - a. Common internal aisle of sufficient width to permit protective device withdrawal, disassembly, and servicing in aisle.
 - b. Aisle access doors at each end with exterior locking provisions and interior panic latches.
 - c. Aisle space heaters operating at one-half or less of rated voltage, thermostatically controlled.

- d. Vaporproof LED aisle lights with low temperature ballasts, controlled by wall switch at each entrance.
 - e. GFCI duplex receptacles, a minimum of two, located in aisle.
 - f. Aisle ventilation louvers equipped with insect and rodent screen and filter and arranged to permit air circulation while excluding rodents and exterior dust.
 - C. Finish: Manufacturer's standard gray finish over rust inhibiting primer on phosphatizing treated metal surfaces.
 - D. Metal Enclosed Bus Transition Unit: Arranged to suit bus and adjacent units.
 - E. Incoming Line Unit: Arranged to suit incoming line.
 - F. Outgoing Feeder Units: Arranged to suit distribution feeders.
 - G. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium voltage components.
 - H. Auxiliary contacts for remote closed and open position indication.
 - I. Protective Device Indicating Lights: Shall be mounted on front door of the switchgear, be removable from the front, and shall be General Electric, Type ET-5 or Westinghouse Minalite type, complete with low voltage lamp, receptacle, and resistor, suitable for operation from a 120 volt ac source, as required. Fifteen percent (15%) spare lamps and two (2) lamp pullers of the bayonet type shall be provided per switchgear lineup.
 - 1. Red shall indicate open.
 - 2. Green shall indicate closed.
 - J. Key Interlocks: Arranged to affect interlocking schemes indicated.
 - K. Provisions for Future Key Interlocks: Mountings and hardware required for future installation of locks, where indicated.
 - L. Rubber Mats:
 - 1. Provide corrugated, non-conductive, rubber mats per Division 26 Section "Hangers and Supports:"
 - a. In operating and maintenance aisles on all sides of each electrical assembly.
 - b. As shown on Drawings or otherwise extending the longer of the electrical assembly or associated housekeeping pad and 4 foot minimum width.
- 2.10 COMPONENTS
- A. Main Bus: Copper, silver plated at connection points; full length of switchgear.
 - B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size 1/4 by 2 inches (6 by 50 mm); full length of switchgear.
 - C. Bus Insulation: Covered with flame retardant insulation.

- D. Metal Clad Switchgear Arc Exhaust Plenum: Provided by switchgear manufacturer to be mounted on and above switchgear to allow arc byproduct gasses to be dispersed properly and not to be reflected back into the area that could be occupied by personnel and to assure potential back pressure does not cause a failure of the arc resistant integrity of the switchgear assembly. Where physical clearances are not possible above the switchgear, provide an extended arc exhaust plenum to vent to the outside of the building that is not accessible to personnel. Provide arc byproduct, rain, snow, and vermin proof vents intended for such use and environmental conditions.
1. For Main-Tie-Main switchgear arrangements, provide barrier separating one main and the tie-breaker from the other main and extend two dedicated output arc ducts to the building exterior.
- E. Instrument Transformers: Comply with IEEE C57.13.
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Burden and minimum C100 accuracy class for connected relays, meters, and instruments.
- F. Multifunction Digital Metering Monitor: Microprocessor based unit suitable for three or four wire systems, listed and labeled by an NRTL, and with the following features:
1. Inputs from sensors or 5-A current transformer secondaries, and potential terminals rated to 600 V.
 2. Switch selectable digital display with the following features:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Three Phase Real Power: Plus or minus 2 percent.
 - e. Three Phase Reactive Power: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
 3. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Division 26 Section "Electrical Power Management Systems."
 4. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.
- G. Analog Instruments: Rectangular, 4-1/2 inches (115 mm) square, 1 percent accuracy, semiflush mounting, with antiparallax 250 degree scale and external zero adjustment, and complying with ANSI C39.1.
1. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
 2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase **and phase-to-neutral** voltages.
 3. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
 4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
 5. Locate meter and selector switch on circuit breaker compartment door for indicated feeder circuits only.

6. Watt Hour Meters: Flush or semiflush mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15 minute indicating demand register, and provision for testing and adding pulse initiation.
 7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15 minute interval.
 - a. Operation: Counts and records a succession of pulses entering two channels.
 - b. Housing: Drawout, back connected case arranged for semiflush mounting.
 - H. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.
 - I. Surge Arresters: Metal oxide varistor type. Comply with NEMA LA 1.
 1. Class:
 - a. Intermediate Class for incoming feeders.
 - b. Distribution Class for outgoing feeders.
 2. Install in cable termination compartments in each phase of circuit.
 3. Coordinate rating with circuit voltage.
 4. Shall be UL listed for use with the lightning protection system.
 - J. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.
 - K. Control Power Supply: DC battery system.
 - L. Control Power Supply: Control power transformer supplies 120 V control circuits through secondary disconnect devices. Include the following features:
 1. Dry type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
 2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
 - a. Secondary windings connected through relay(s) to control bus to affect an automatic transfer scheme.
 - b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
 3. Control Power Fuses: Primary and secondary fuses provide current limiting and overload protection.
 - M. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
 1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
 2. Conductors sized according to NFPA 70 for duty required.
- 2.11 LINEUP 1MVS1
- A. Ratings:
1. System Voltage: 13.8 KV Y
 2. BIL: 95 KV
 3. Frequency: 60 Hz
 4. Main Bus: 1200 ampere continuous
 5. MVA Short Circuit: 500 MVA symmetrical
 6. Ground Bus: 1/4 inch by 2 inch full perimeter
 7. Maximum Temp: 40 degrees C

8. Minimum Temp: 25 degrees C
9. Elevation: 220 feet
10. **[Arc Resistant Type: 2B]**

B. Front Left to Right Lineup Assembly Section Arrangement:

Identification	Section Description
52/M1	Main Breaker Number 1
UM1	Utility Metering Number 1
52/F1 and 52/F3	Feeder Breakers Number F1 and F3
52/F5 and 52/F7	Feeder Breakers Number F5 and F7
52/SPR and 52 SPC	Feeder Breaker Spare and Space
52/T1	Tie Breaker Number 1
52/SPR and 52/SPC	Feeder Breaker Spare and Space
52/F6 and 52/F8	Feeder Breakers Number F6 and F8
52/F2 and 52/F4	Feeder Breakers Number F2 and F4
UM2	Utility Metering Number 2
52/M2	Main Breaker Number 2

C. Lineup Equipment:

1. The following is a list, by quantity and type, of the protective devices (relays, timers), instruments, switches, etc. as a design basis for each lineup cubicle. This list is submitted for guidance only. The switchgear shall be designed and equipped to meet the functions specified.
 - a. For each main metal clad breaker 52/M1 and 52/M2, the following equipment is anticipated:
 - 1) 3 - Type 50/51 relays.
 - 2) 1 - Type 50N/51N relay.
 - 3) 3 - Type 87 relays.
 - 4) Line and load side bushing CTs.
 - 5) 3 - Load side PTs.
 - 6) Electric utility termination and testing provisions.
 - 7) Load side station class lightning arresters rated XX KV, type MCOV.
 - 8) Kirk key interlocks.
 - 9) Electric line switch interlock.
 - 10) Multifunction Digital Metering Monitor.
 - 11) Position contacts and pilot lights.
 - b. For tie breaker 52/T1, the following equipment is anticipated:
 - 1) Kirk key interlocks.
 - 2) Electric line switch interlock (one 89 relay required for interlock).
 - 3) (6) CTs.
 - 4) Position contacts and pilot lights.
 - 5) The kirk key and electric line switch interlock shall permit only two of the following devices to be closed at one time:
 - a) 52/M1.
 - b) 52/M2.
 - c) 52/T1.

- c. For each utility metering section UM1 and UM2, the following equipment is anticipated:
 - 1) Electric utility current and potential transformer provisions with access padlocking. The utility metering instrument transformers will be as follows:
 - a) CT – (3) <XXXX>.
 - b) PT – (3) <XXXX>.
- d. For each feeder and spare breaker 52/F#, the following equipment is anticipated:
 - 1) 3 - Type 50/51 relays.
 - 2) 1 - Type 50N/51N relay.
 - 3) Line and load side bushing CTs.
 - 4) Multifunction Digital Metering Monitor.
 - 5) Position contacts and pilot lights.
- e. Make provision for addition of future sections at both ends of the switchgear.

2.12 LINEUP 1MVS2

- A. The following is a list, by quantity and type, of the protective devices (relays, timers), instruments, switches, etc. as a design basis for each lineup cubicle. This list is submitted for guidance only. The switchgear shall be designed and equipped to meet the functions specified.
- B. Ratings:
 - 1. System Voltage: 4.16 KV
 - 2. BIL: 60 KV
 - 3. Frequency: 60 Hz
 - 4. Main Bus: 1200 ampere continuous
 - 5. MVA Short Circuit: 350 MVA symmetrical
 - 6. Ground Bus: 1/4 inch by 2 inch full perimeter
 - 7. Maximum Temp: 40 degrees C
 - 8. Minimum Temp: 25 degrees C
 - 9. Elevation: 220 feet
 - 10. **[Arc Resistant Type: 2B]**
- C. Front Left to Right Lineup Assembly Section Arrangement:

Identification	Section Description
MS1	Main Switch Number 1
UM1	Utility Metering Number 1
FS1	Feeder Switch Number FS1
FS2	Feeder Switch Number FS2
FS3	Feeder Switch Number FS3
SPR	Feeder Switch Spare

- D. Lineup Equipment:
 - 1. The following is a list, by quantity and type, of the protective devices (relays, timers), instruments, switches, etc. as a design basis for each lineup cubicle. This list is submitted for guidance only. The switchgear shall be designed and equipped to meet the functions specified.
 - a. For main switch MS1, the following equipment is anticipated:
 - 1) 3 – Electronic fuses of ratings indicated on single-line Drawing.
 - 2) 3 – Load side CTs.

- 3) 3 – Load side PTs.
- 4) Electric utility termination and testing provisions.
- 5) Load side station class lightning arresters rated XX KV, type MCOV.
- 6) Multifunction Digital Metering Monitor.
- 7) Position contacts and pilot lights.

b. For each utility metering section UM1 and UM2, the following equipment is anticipated:

- 1) Electric utility current and potential transformer provisions with access padlocking. The utility metering instrument transformers will be as follows:
 - a) CT – (3) <XXXX>.
 - b) PT – (3) <XXXX>.

c. For each feeder and spare switch FS#, the following equipment is anticipated:

- 1) 3 – Current limiting fuses of ratings indicated on single-line Drawing.
- 2) Position contacts and pilot lights.

d. Make provision for addition of future sections at both ends of the switchgear.

2.13 REMOTE CIRCUIT BREAKER CONTROL STATION

- A. Remote Tripping Device: Wall mounted control station box to match switchgear enclosure with:
1. Mimic bus nameplate depicting bus, circuit breaker positions, and source or feeder identifications.
 2. Circuit breaker close and trip operators matching functionality on switchgear assembly circuit breaker compartment.

2.14 GROUNDING AND TEST DEVICE SYSTEM

- A. General: System shall be suitable for phasing out, testing, or grounding the switchgear bus or the feeder when the device is installed in place of the breaker at any circuit breaker position. System shall include the following:
1. Portable grounding and test device interchangeable with draw out medium voltage circuit breakers and providing interlocked access to either bus or feeder. Device shall be electrically operated.
 2. Control cabinet for system, permanently mounted in vicinity of switchgear.
 3. Portable remote control station for grounding and test device.
 4. Coupler cable of adequate length for connecting between device, when inserted in any switchgear cubicle, and control cabinet.
 5. Coupler cable for connecting between control cabinet and remote control station, to permit operating device from a safe distance. (50 foot cable length).
 6. Permanent control power wiring from control cabinet to power source.
 7. Fitted cover for device, of heavy duty plastic.
- B. Approval: Final system design shall be as approved by the power company and the Architect.
- C. Automatic Control Systems.

2.15 REMOTE RACKING SYSTEM

- A. Provide a motorized remote racking system for new switchgear assemblies. System shall include:
1. Power supply from assembly control transformer, 120 VAC source.
 2. Front mounted 120 VAC receptacle for temporary motor and pendant control.
 3. Permanently installed racking motors and drive system for each vacuum circuit breaker.

4. Remote control panel wall mounted at remote location for each assembly.
5. Control system and logic for remote racking function.
6. Interconnecting wiring between system components and to remote control panels.

2.16 CIRCUIT BREAKER TEST CABINET

- A. Test Cabinet: Separately mounted test cabinet containing pushbuttons for breaker closing and tripping, control relay, fuses, and secondary coupler with cable approximately 9 feet long. Provide a set of secondary devices for operating the breaker when removed from the switchgear and moved to the vicinity of the test cabinet. Cabinet shall have provisions for storage of test and maintenance accessories. Locate the cabinet as indicated.

2.17 CIRCUIT BREAKER EMERGENCY CONTROL STATION

- A. Remote Tripping Device: Wall mounted, emergency control station outside the switchgear room where indicated, housed in a red cast metal box. Operation of the control station shall cause all medium voltage circuit breakers to open. The outer glass must be broken before the emergency trip button is pushed.

2.18 CONTROL BATTERY SYSTEM

- A. System Requirements: Battery shall have number of cells and ampere hour capacity based on an initial specific gravity of 1.210 at 25 degrees C with electrolyte at normal level and minimum ambient temperature of 13 degrees C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded.
- B. Battery: Lead calcium type in sealed, clear plastic or glass containers, complete with electrolyte, fully charged and arranged for shipment with electrolyte in cells. Limit weight of each container to not more than 70 lbs (32 kg) and cells per container to not more than 3. System batteries shall be suitable for service at an ambient temperature ranging from minus 18 to 25 degrees C. Limit variation of current output to 0.8 percent for each degree below 25 degrees C down to minus 8 degrees C.
- C. Rack: Two step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted type terminals for output leads. **[Rate battery rack, cell supports, and anchorage for seismic requirements.]**
- D. Accessories:
 1. Thermometers with specific gravity correction scales.
 2. Hydrometer syringes.
 3. Set of socket wrenches and other tools required for battery maintenance.
 4. Wall mounted, nonmetallic storage rack fitted to store above items.
 5. Set of cell numerals.
- E. Charger: Static type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input voltage variation of plus or minus 10 percent and input frequency variation of plus or minus 3 Hz. Other features of charger include the following:
 1. DC ammeter.
 2. DC Voltmeter: Maximum error of 5 percent at full charge voltage; operates with toggle switch to select between battery and charger voltages.
 3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by normally open push button contact.

4. Capacity: Sufficient to supply steady load, float charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
5. Charging Rate Switch: Manually operated switch provides for transferring to higher charging rate. Charger operates automatically after switch operation until manually reset.
6. AC power supply is 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3 Hz variation in frequency. After loss of ac power supply for any interval, charger automatically resumes charging battery. Charger regulates rate of charge to prevent damage due to overload and to prevent fuses or circuit breakers from opening.
7. Protective Feature: Current limiting device or circuit, which limits output current to rating of charger but does not disconnect charger from either battery or ac supply; to protect charger from damage due to overload, including short circuit on output terminals.
8. Electrical Filtering: Reduces charger's audible noise to less than 26 dB.

2.19 MEDIUM VOLTAGE METAL ENCLOSED BUSWAY

- A. Manufacturers shall match associated switchgear manufacturers.
- B. Comply with NEMA, ANSI/IEEE C37.23, NFPA 70, and NFPA 70E.
- C. Ratings:
 1. Voltage: 4.16 KV nominal, 4.76 KV maximum.
 2. Current: 2000 amperes.
 3. BIL: 60 KV.
 4. Short Circuit Withstand: 350 MVA.
 5. Busbar Temperature Rise: 65 degrees C.
 6. Conductor Insulation System: 105 degree C at 5 KV class, continuous; meet or exceed requirements of ANSI/C37.23, Table 5.
- D. Construction:
 1. Copper conductors, type EPT 110 or ASTM designation B187.
 2. Outdoor construction, totally enclosed, non-ventilated, weather resistant and sealed to prevent entrance of water.
 3. Conductor supports to provide rigid structural bracing for conductors and insulators and rated to withstand short circuit currents specified. Supports to be non-hygroscopic, track resistant, flame retardant, glass reinforced polyester blocks, suitable for 5 KV system.
 4. Bus joints shall utilize high strength plated steel hardware. Contact surfaces of bolted copper joints shall be silver plated. Overlap type splice joints shall be provided where required. The limitation of hottest spot temperature rise shall meet the requirements of ANSI/IEEE C37.23, Table 1.
 5. Grounding: The busway housing shall be designed to carry maximum ground fault current for a minimum of two seconds, without exceeding rated temperature rise of 80 degrees C. Flexible jumpers shall be provided at all expansion joints to ensure ground continuity.
 6. Configuration: Three phase, four wire plug ground; full capacity phase busses (3), full capacity neutral bus, 50 percent capacity ground bus.
 7. Enclosure: The busway enclosure shall be designed for freestanding, self-supporting construction; designed for a maximum temperature rise of 40 degrees C when carrying rated current in 40 degrees C ambient conditions. Provide enclosure joints and expansion joints as required to accommodate site conditions and linear expansion up to one inch. All enclosure hardware shall be stainless steel. The top cover joints and joints with end flanges shall be flanged, gasketed, and protected with a metallic sealing strip. Screen breathers and drains shall be provided along bottom covers and at low points.
- E. Entrances: Seal all busway entrances at switchgear enclosures.

2.20 IDENTIFICATION

- A. Per Division 26 Section "Electrical Identification."

2.21 SOURCE QUALITY CONTROL

- A. Before shipment of equipment, perform the following tests and prepare test reports:
1. Production tests on circuit breakers according to ANSI C37.09.
 2. Production tests on completed switchgear assembly according to IEEE C37.20.2.
- B. Assemble switchgear and equipment in manufacturer's plant and perform the following:
1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
 2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.
- C. Prepare equipment for shipment.
1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

2.22 FACTORY FINISHES

- A. Finish: Manufacturer's standard color finish applied to equipment before shipping.

2.23 RUBBER MATS

- A. Provide corrugated, nonconductive, rubber mats:
1. In operating and maintenance aisles on all sides of each electrical assembly including battery racks.
 2. As shown on Drawings or otherwise extending the longer of the electrical assembly or associated housekeeping pad and 4 foot minimum width.
- B. Comply with ANSI/ASTM D178 Type II, Class 2 requirements including:
1. Minimum dielectric strength of 30,000 volts AC RMS.
 2. Maximum use of 17,000 volts AC RMS.
 3. Minimum 1/4 inch thickness.
- C. Acceptable Manufacturers:
1. American Floor Mats.
 2. Mats Etc.
 3. Mats, Inc.
 4. Ranco Industries, Inc.
 5. Salisbury, a Division of Honeywell.

PART 3 - EXECUTION – NOT USED

END OF SECTION 261300

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SECTION 262200 - LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Preference is for all electrical distribution equipment to be installed indoors. If outdoor transformer is required due to space constraints, enclose in yard, caged top, with locked door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers.
 - 1. Basis of design:
 - a. GE Industrial Solutions; a member of ABB Group.
 - b. Square D Co.
 - 2. Acceptable Manufacturers:
 - a. Acme Electric Corp.; Power Distribution Products Division.
 - b. Eaton Electrical; Cutler-Hammer Products.
 - c. Jefferson Electric.
 - d. Hammond Power Solutions.
 - e. Hevi-Duty Electric.
 - f. Mirus International, Inc.
 - g. Siemens Energy & Automation, Inc.

2.2 REGULATORY REQUIREMENTS

- 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:
 - 1. ANSI C57.12.01/NEMA ST-20 Dry-Type Transformer for General Applications.
 - 2. IEEE C57.110-IEEE Recommended Practice for Establishing Transformer Capability When Feeding Non-Sinusoidal Load Currents.
 - 3. IEEE C57.12.91-IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
 - 4. IEEE 1100 – IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.
 - 5. NEMA ST1 – Specialty Transformers.
 - 6. NEMA TP2 – Standard Test Method for Measuring Energy Consumption of Distribution Transformers.
 - 7. DOE 2016:
 - a. Federal Register – US Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy. 10 CFR Part 431, Energy Conservation Program for Certain Commercial and Industrial Equipment: Energy Conservation Standards for Distribution Transformers.
 - b. Federal Register - US Department of Energy (DOE), Office of Energy and Renewable Energy. 10 CFR Part 429, Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment.
 - 8. UL 1561 Dry Type General Purpose and Power Transformers.

9. UL 506 Safety Standard for Specialty Transformers.

2.3 SEISMIC PERFORMANCE

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 GENERAL TRANSFORMER DESIGN CRITERIA

- A. Description: Factory-assembled and tested air cooled units of types specified, having characteristics and ratings as indicated. Units shall be designed for 60 Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 1. Complying with DOE 2016 efficiency levels in 10 CFR 431.196.
 2. Tested according to 10 CFR 431.193, Appendix A to Subpart K "Distribution Transformers."
- D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
- E. Coils: Continuous windings without splices except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper.
- F. Equipment Ground Bus: Copper 2 inch by 1/4 inch by necessary length to accommodate independent grounding conductor lugs per transformer grounding details.
 1. Provide transformer enclosure bonding jumper and ground bus provisions on side wall of enclosure easily accessible from front cover per Division 26 Section "Grounding and Bonding."
- G. Transformer primary and secondary terminals shall be front connected for ease of installation and maintenance. Ensure minimum 1 inch clearance to enclosure from terminals and lugs. Coil leads shall be suitable to receive solderless crimp type lugs on a rigid braced and insulated terminal board.
- H. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- I. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.
- J. Ratings:
 1. As shown on Drawings.
 2. Minimum impedances and US DOE 10 CFR Part 431 and 429 Efficiencies for 3 phase applications shall be as follows:

KVA	K=1 Minimum Percent Impedance						General Purpose Minimum DOE 2016 10 CFR Part 431 and 429 Efficiencies at 75 degrees C and 35% Linear Load
	Copper			Aluminum			
	150	115	80	150	115	80	
15	2.8	2.7	1.6	3.7	3.5	1.6	97.89
30	2.5	2.3	2.0	2.7	2.2	2.4	98.23
45	3.4	3.4	1.9	3.5	3.8	2.9	98.40
75	3.2	2.9	2.6	3.6	3.8	2.8	98.60
112.5	3.6	4.0	2.6	4.3	4.2	2.6	98.74
150	3.3	3.5	3.4	3.4	3.7	2.9	98.83
225	4.3	3.3	3.2	4.2	5.3	3.2	98.94
300	3.5	4.1	3.8	4.4	4.0	3.1	99.02
500	4.5	6.0	3.3	4.9	5.2	3.3	99.14
750	5.2	6.0	5.4	5.0	7.5	5.1	99.23
1000	5.2	5.3	5.1	5.8	6.7	5.3	98.82

2.5 GENERAL PURPOSE, DRY TYPE TRANSFORMERS

- A. Comply with NEMA Standard ST 20 "Dry-Type Transformers for General Applications."
- B. Provide transformers that are internally braced to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls."
- C. Windings: Two winding copper type. Three phase transformers shall use one coil per phase in primary and secondary. Primary winding shall be Delta connected and secondary winding shall be Wye connected unless otherwise shown on Drawings.
- D. 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.
- E. Transformers shall be generally installed in an indoor ventilated enclosure, NEMA 250, Type 2. Other enclosure types, as shown on Drawings, may be:
 1. Indoor, ventilated, dripproof.
 2. Outdoor, ventilated, raintight, NEMA 3R.
 3. Totally enclosed, nonventilated.
 4. Totally enclosed, nonventilated, suitable for outdoor use.
- F. Insulation Class: 220 degrees C class for transformers 15 kVA or smaller; 220 degrees C class for transformers larger than 15 kVA.
- G. Insulation Temperature Rise: 115 degrees C maximum rise above 40 degrees C.
- H. Minimum efficiencies shall be per US DOE 10 CFR Part 431 and 429 and local energy codes.
- I. Taps: For transformers 3 kVA and larger, full capacity taps in high voltage winding as follows:
 1. 3 kVA through 10 kVA: Two 5 percent taps below rated high voltage.
 2. 15 kVA through 500 kVA: Six 2-1/2 percent taps, 2 above and 4 below rated high voltage.
 3. 750 through 1000 kVA: Four 2-1/2 percent taps, 2 above and 2 below rated high voltage.

J. **[Accessories: As follows:]**

1. Surge Arresters: Low-voltage type, factory-installed and connected to high voltage terminals; complying with NEMA Standard LA 1.
2. Surge Arresters: Low-voltage type, factory-installed and connected to low voltage terminals; complying with NEMA Standard LA 1.
3. Wall Mounting Brackets: Manufacturers standard brackets for transformers sized up to 75 kVA where wall mounting is indicated.

2.6 K RATED DRY TYPE TRANSFORMERS FOR NON-LINEAR, NON-SINUSOIDAL LOADS

- A. Comply with NEMA Standard ST1 "Specialty Transformers," UL Standard 506 "Specialty Transformers" and UL Standard 1561.
1. The transformer shall be designed, UL listed and labeled stating "SUITABLE FOR NON-SINUSOIDAL CURRENT LOADS, WITH A K FACTOR NOT TO EXCEED (*)." (* Shall be 4, 13, 20, 30, 40, or 50 as scheduled on Drawings).
- B. K Factor Rating: Transformers indicated to be K factor rated shall comply with UL 1561 requirements for nonsinusoidal load current handling capability to the degree defined by designated K factor.
1. Unit shall not overheat when carrying full load current with harmonic distortion corresponding to designated K factor.
 2. Indicate value of K factor on transformer nameplate.
- C. Electrostatic Shielding: Each winding shall have an independent, single, full width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 2. Include special terminal for grounding the shield.
 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common Mode Noise Attenuation: Minus 80 dBA minimum at 0.5 to 1.5 kHz; minus 65 dBA minimum at 1.5 to 100 kHz.
 - c. Normal Mode Noise Attenuation: Minus 52 dBA minimum at 1.5 to 10 kHz.
- D. Windings: Two winding, copper, three phase type. Primary winding shall be delta connected and secondary winding shall be wye connected.
- E. 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.
- F. Transformers shall be generally installed in an indoor ventilated enclosure, NEMA 250, Type 2. Other enclosure types, as shown on Drawings, may be:
1. Indoor, ventilated, dripproof.
 2. Outdoor, ventilated, raintight, NEMA 3R.
 3. Totally enclosed, nonventilated.
 4. Totally enclosed, nonventilated, suitable for outdoor use.
- G. Insulation Class: 220 degrees C for transformers larger than 15 kVA.

- H. Insulation Temperature Rise at Rated Voltage and Full Load: 115 degrees C maximum rise above 40 degrees C.
- I. Minimum efficiencies shall be per DOE 2016 and local energy codes as applicable.
- J. Taps: For transformers 15 kVA and larger, full capacity taps in high voltage windings as follows:
 - 1. 15 kVA through 500 kVA: Six 2-1/2 percent tap, 2 above and 4 below rated high voltage.
 - 2. 750 kVA through 1000 kVA: Four 2-1/2 percent taps, 2 above and 2 below rated high voltage.
- K. Basic Impulse Level of Windings: 10 kV.
- L. The secondary neutral terminal shall be 200 percent the capacity of the typical secondary phase terminal.
- M. The core flux density shall be well below the saturation point to prevent core saturation caused by the harmonics even with a 10 percent primary overvoltage.

2.7 BUCK-BOOST TRANSFORMERS

- A. Description: Self cooled, two winding dry type, rated for continuous duty.
- B. Comply with NEMA Standard ST 1 "Specialty Transformers," and UL Standard 506, "Specialty Transformers."
- C. Ratings: As shown on Drawings, and for continuous duty.
- D. Type: Self cooled, dry type, connected as auto transformers to provide the percentage of buck or boost indicated.
- E. Enclosure: Suitable for the location indicated.
- F. Sound Level: Minimum of 3 dB less than NEMA ST 1 standard for transformer of type and size indicated when factory tested in accordance with that standard.

2.8 CONTROL AND SIGNAL TRANSFORMERS

- A. Description: Self cooled, two winding dry type, rated for continuous duty.
- B. Comply with NEMA Standard ST 1 "Specialty Transformers," and UL Standard 506, "Specialty Transformers."
- C. Ratings: As shown on Drawings and recommended by manufacturer of served load and for continuous duty. Where ratings are not shown on Drawings, provide capacity in excess of load.
- D. Type: Self cooled, two winding dry type.
- E. Enclosure: Indoor, except as indicated.

2.9 VOLTAGE REGULATING TRANSFORMERS

- A. Comply with applicable requirements of ANSI/IEEE Standard C57.15, "IEEE Standard Requirements, Terminology and Test Code for Step-Voltage and Induction-Voltage Regulators."
- B. Type: Ventilated, self-cooled, electronic tap switching unit with no moving parts, arranged for automatic changing of turns ratio of transformer to correct up to 15 percent excursions of voltage from set value to within 1 percent of that value within 2 cycles of the excursion incident while under 100 percent load.
- C. Controls: Solid state type arranged to perform tap switching at zero value line current to minimize voltage transients. Controls shall permit external adjustment of voltage set value over a minimum band of 5 percent above and below rated output voltage.

LOW VOLTAGE TRANSFORMERS

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- D. Rating: Input and output voltage ratings and output capacity ratings as indicated.
- E. Phase: **[Single phase] [Three phase]**.
- F. Harmonics: Harmonic content of output during voltage corrections up to 15 percent, and for loads from 25 percent to 100 percent, shall not exceed 3 percent.
- G. Enclosure: **[NEMA 1] [Indoor, dripproof]**.

2.10 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated plastic or metal nameplate for each **[distribution] [buck-boost]** transformer, mounted with corrosion resistant screws. Nameplates and label products are specified in Division 26 Section "Electrical Identification."

2.11 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
 - 1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
 - 2. Ratio tests at the rated voltage connections and at all tap connections.
 - 3. Phase relation and polarity tests at the rated voltage connections.
 - 4. No load losses, and excitation current and rated voltage at the rated voltage connections.
 - 5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
 - 6. Applied and induced tensile tests.
 - 7. Regulation and efficiency at rated load and voltage.
 - 8. Insulation Resistance Tests:
 - a. High voltage to ground.
 - b. Low voltage to ground.
 - c. High voltage to low-voltage.
 - 9. Temperature tests.
- B. Factory Sound

PART 3 - EXECUTION – NOT USED

END OF SECTION 262200

SECTION 262300 - LOW VOLTAGE POWER SWITCHGEAR

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the same manufacturers as project panelboards.

2.2 REGULATORY REQUIREMENTS

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Assembly Selection: The Drawings indicate sizes, profiles, and dimensional requirements of assembly equipment. Equipment having equal performance characteristics and complying with indicated maximum dimensions and profiles may be considered, provided deviations do not change the design concept intended performance, or code/future extension provision clearances. The burden of proof of equality is on the proposer a minimum of 10 days prior to bid.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.

2.3 SEISMIC PERFORMANCE

- A. Seismic Performance: Low voltage power switchgear shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 RATINGS

- A. **[Nominal System Voltage: [480/277 V, 4] [208/120 V, 4] wire, 60 Hz].**
- B. **[Nominal System Voltage: As scheduled on Drawings.]**
- C. **[Main Bus Continuous: [4000] [3200] [2000] [1600] <Insert other> A].**
- D. **[Main Bus Continuous: As scheduled on Drawings.]**
- E. **[Short Time and Short Circuit Current: Match rating of highest rated circuit breaker in switchgear assembly.]**
- F. **[Short Time and Short Circuit Current: As scheduled on Drawings.]**
- G. Short Circuit Current: The equipment shall be constructed and braced to withstand forces exerted by an available short circuit of **[42,000] [65,000] [85,000] [100,000] [as scheduled on Drawings].**

2.5 FABRICATION

- A. Factory assembled and tested and complying with IEEE C37.20.1[, **ANSI C37.20.7 (for arc resistant testing)**].
- B. Indoor Enclosure Material: Steel.
- C. Outdoor Enclosure Material: Galvanized steel.
- D. Outdoor Enclosure Fabrication Requirements: Weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating; and each compartment equipped with the following features:
 - 1. Structural design and anchorage adequate to resist loads imposed by [125-mph (200-km/h)] wind.
 - 2. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
 - 3. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
 - 4. Hinged front door with padlocking provisions.
 - 5. Interior light with switch.
 - 6. Weatherproof duplex receptacle.
- E. Arc Resistant Construction:
 - 1. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover.
 - 2. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within enclosure. The top of enclosure shall also have arc ventilation flaps that allow exhaust of arc gases during an arcing event. These flaps shall remain closed during normal operation.
 - 3. An arc ventilation system shall be provided within each breaker cell to redirect energy to the top of the enclosure away from operation personnel.
 - 4. The switchgear shall have a ventilation system that allows exhaust of dangerous arc gasses regardless of the origination location of the arc event. The ventilation system shall be designed to exhaust arc events originating in the breaker cell, bus compartment, and rear cable compartment.
 - 5. The arc rating of the switchgear shall be Type 2B (operator protected around entire perimeter of equipment, even with the low voltage control compartment door open) as defined by ANSI C37.20.7.
- F. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust inhibiting primer on phosphatizing-treated metal surfaces.
- G. Section barriers between main and tie circuit breaker compartments shall be extended to rear of section.
- H. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
- I. Circuit breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
- J. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.
- K. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
 - 1. Utility metering compartment that complies with utility company requirements.
 - 2. Bus transition sections.
 - 3. Incoming line pull sections.
 - 4. Hinged front panels for access to metering, accessory, and blank compartments.

5. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
 - a. Set pull box back from front to clear circuit-breaker lifting mechanism.
 - b. Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
 - c. Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.
6. Fire Pump Tap:
 - a. Provide fire pump tap section in a separate barriered compartment on the line side of the main disconnect(s) and associate bus and tap lugs to feed the fire pump.
- L. Busbars connect between vertical sections and between compartments. Cable connections are not permitted.
 1. Main Phase Bus: Uniform capacity the entire length of assembly.
 2. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
 3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
 4. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
 5. Phase- and Neutral-Bus Material: Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.
 6. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.
 7. Use silver-plated copper or tin-plated aluminum for connecting circuit-breaker line to aluminum bus.
 8. Use copper for connecting circuit-breaker line to copper bus.
 9. Contact Surfaces of Buses: Silver-plated.
 10. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
 11. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches (6 by 50 mm).
 12. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
 13. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
 14. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch (6-by-50-mm) copper bus, arranged to connect neutral bus to ground bus.
 15. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
 16. Busbar Insulation: Individual busbars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
 - a. Sprayed Insulation Thickness: 3 mils (0.08 mm), minimum.
 - b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

2.6 INSTRUMENTATION

- A. Instrument Transformers: Comply with IEEE C57.13.
1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.
- B. Multi-Function Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit in compliance with Division 26 Section "Electrical Power Management Systems" suitable for three- or four-wire systems and with the following features:
1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 2. Switch-selectable digital display of the following:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Three-Phase Real Power: Plus or minus 2 percent.
 - e. Three-Phase Reactive Power: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
 3. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
- C. Multi-Function Dual/Redundant Programmable Logic Controllers (PLCs): Industrial grade redundant microprocessor-based unit in compliance with Division 26 Section "Electric Power Management Systems", suitable for three or four wire systems and with the following features:
1. Master PLC and on-line hot backup PLC.
 2. Protective devices, sensors, analog signals and digital network centralized control architecture.
 3. Full Color Human Machine Interface (HMI) Device: Touchscreen LCD display with minimum diagonal viewing area of 15 inches.
 4. Operator shall be able to monitor and control through remote PC per Division 26 Section "Electric Power Management System" (EPMS) the following switchboard screens and functionalities:
 - a. Main Menu: Include date, time, and system status messages with screen pushbuttons to access one-line diagram, system controls, load controls, alarms, bus metering, etc., as required by the installation.
 - b. One-line diagram screen.
 - c. System control screen.
 - d. Alarm summary and historical event capture/report screen.
 - e. Protective device status, settings and loads.
 - f. Protective device individual tripping functions per Division 26 Sections "Protective Devices" and "Protective Device Coordination."
 - g. Protective device zone selective interlocking (ZSI) functions [**including ground fault interlocking**].
 - h. Bus differential protection.
 - i. **[Key interlock(s) status.]**

j. **[Communication and features to meet EPMS system requirements.]**

- D. Zone Selective Interlocking (ZSI): Assembly integrated microprocessor based system per Division 26 Section "Protective Devices."
- E. Arc Flash Protection System (AFPS): Assembly integrated microprocessor based system per Division 26 Section "Protective Devices."
- F. Analog Instruments: Rectangular, 4-1/2-inch (115-mm) square, accurate within 1 percent, semi-flush mounting, with anti-parallax 250-degree scale and external zero adjustment, complying with ANSI C39.1.
 - 1. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
 - 2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
 - 3. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
 - 4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
 - 5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
 - 6. Watt-Hour Meters: Flush- or semi-flush mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
 - 7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
 - a. Operation: Meter counts and records a succession of pulses entering two channels.
 - b. Housing: Drawout, back-connected case arranged for semi-flush mounting.
- G. Indicating Lights: Breaker open and breaker closed, for main and bus tie circuit breakers interlocked wither with each other or with external devices.
- H. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

2.7 COMPONENTS

- A. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.
- B. Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.
- C. Arc Exhaust Plenum: Provided by switchgear manufacturer to be mounted on and above switchgear to allow arc byproduct gasses to be dispersed properly and not to be reflected back into the area that could be occupied by personnel and to assure potential back pressure does not cause a failure of the arc resistant integrity of the switchgear assembly. Where physical clearances are not possible above the switchgear, provide an extended arc exhaust plenum to vent to the outside of the building that is not accessible to personnel. Provide arc byproduct, rain, snow, and vermin proof vents intended for such use and environmental conditions.
 - 1. For Main-Tie-Main switchgear arrangements, provide barrier separating one main and the tie-breaker from the other main and extend two dedicated output arc ducts to the building exterior.
- D. Control Power Supply: Control power transformer supplying 120V control circuits through secondary disconnect devices. Include the following features:
 - 1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.

2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
 - a. Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
 - b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
 3. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.
 4. Fuses are specified in Division 26 Section "Protective Devices."
- E. Infrared (IR) View Panes: IR transmittance lens secured and sealed to assembly enclosure to allow inspection of electrical transmission components without elevated levels of Personal Protective Equipment (PPE). Locate view panels on **[front]** **[and]** **[back]** of enclosure to allow use of cameras with 2x to 3x horizontal and 1.5x to 2x vertical distance to target with a maximum angle of incidence of 30 degrees to view all greater than 70 volt cable, busbar, and protective device connections within the assembly. Label each window by number, instructions for use, lens material, window transmission rates, and target components; location by clock face method; and baseline emissivity (e.g., "Busbar Connection: 2 o'clock: E = 0.95").
- F. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
 2. Conductors sized according to NFPA 70 for duty required.

2.8 REMOTE CIRCUIT BREAKER CONTROL STATION

- A. Remote Tripping Device: Wall mounted control station box to match switchgear with:
1. Mimic bus nameplate depicting bus, circuit breaker positions, and source or feeder identifications.
 2. Circuit breaker close and trip operators matching functionality on switchgear assembly circuit breaker compartment.

2.9 LOW VOLTAGE DRAWOUT POWER CIRCUIT BREAKERS

- A. Description: Comply with IEEE C37.13.
- B. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
- C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
1. Normal Closing Speed: Independent of both control and operator.
 2. Slow Closing Speed: Optional with operator for inspection and adjustment.
 3. Stored-Energy Mechanism: **[Manually charged] [Electrically charged, with optional manual charging]**.
 4. Operation counter.
- D. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
 2. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.

3. Field-adjustable, time-current characteristics.
 4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
 5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
 6. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I²t operation.
 7. Pickup Points: Five minimum, for instantaneous-trip functions.
 8. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
 - a. Three-wire circuit or system.
 - b. Four-wire circuit or system.
 - c. Four-wire, double-ended substation.
 9. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
- E. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.
- F. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
 2. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
 - a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
 - b. Disconnected Position: Primary and secondary devices and ground contact disengaged.
- G. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
- H. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
- I. Operating Handle: One for each circuit breaker capable of manual operation.
- J. Electric Close Button: One for each electrically operated circuit breaker.
- K. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
- L. Key Interlocks: Arranged so keys are attached at devices indicated per requirements of Division 26 Section "Protective Devices." Mountings and hardware are included where future installation of key interlock devices is indicated.
- M. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage.

- N. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.
- O. Shunt-Trip Devices: Where indicated.
- P. Fused Circuit Breakers: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:
 - 1. Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
 - 2. Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on a common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.
 - 3. Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.
 - 4. Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when a fuse opens. Open-fuse status is indicated at front of circuit breaker or fuse drawout element.
- Q. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

2.10 ACCESSORY COMPONENT AND FEATURES

- A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
 - 1. Racking handle to manually move circuit breaker between connected and disconnected positions.
 - 2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
 - 3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
- B. Automatic Throwover – Double Ended Switchgear:
 - 1. An automatic throwover scheme shall be supplied where shown on Drawings and as specified. The sequence of operation shall be such that upon loss of voltage to the line side of a main breaker and after a field adjustable time delay, that main breaker shall open and then the tie breaker shall close. Upon restoration of voltage to the line side of the main breaker and after a field adjustable time delay, the tie breaker shall open and after a field adjustable time delay, the main shall close.
 - a. The following features shall also be included:
 - 1) A manual-automatic mode selector switch.
 - 2) The mains and tie shall be electrically interlocked such that no more than two can be closed at one time.
 - 3) If the main and tie devices open due to a fault condition, all automatic transfer shall be locked out until manually reset.
 - 4) Digital metering may be used for detections.
 - 5) PLC: Programmed by manufacturer per time delays as determined by Engineer. At least two revisions by Engineer shall be performed, if necessary, at no extra charge.
 - 6) Provide two auxiliary contacts on each main and tie device.

- C. Surge Protection Device (SPD): As shown on Drawings and defined in Division 26 Section "Surge Protection for Low Voltage Electrical Power Circuits" for low voltage switchgear.
- D. Circuit Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
- E. Circuit Breaker Removal Apparatus: Overhead circuit breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.
- F. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.
- G. Rubber Mats:
 - 1. Provide corrugated, non-conductive, rubber mats per Division 26 Section "Hangers and Supports":
 - a. In operating and maintenance aisles on all sides of each electrical assembly.
 - b. As shown on Drawings or otherwise extending the longer of the electrical assembly or associated housekeeping pad and 4 foot minimum width.
- H. Control Battery System: As per Division 26 Section "Medium Voltage Switchgear" for switchgear redundant control battery system.

2.11 IDENTIFICATION

- A. Identification Materials: Refer to Division 26 Section "Electrical Identification." Identify units, devices, controls, and wiring.
- B. Compartment Nameplates: Engraved plastic laminate or metal nameplate for each compartment, mounted with corrosion-resistant screws.
- C. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
 - 1. Mimic bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
 - 2. Medium: Painted graphics, as selected by Engineer.
 - 3. Color: Contrasting with factory-finish background; as selected by Engineer from manufacturer's full range.
- D. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
 - 1. Frame size of each circuit breaker.
 - 2. Trip rating for each circuit breaker.
 - 3. Conduit and wire size for each feeder.

PART 3 - EXECUTION – NOT USED

END OF SECTION 262300

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SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Preference is for all electrical distribution equipment to be installed indoors. If outdoor switchboard is required due to space constraints, enclose in yard, caged top, with locked door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the same manufacturers as project panelboards.

2.2 REGULATORY REQUIREMENTS

- 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 NEMA PB 2, "Deadfront Distribution Switchboards."
- C. Comply with NFPA 70.
- D. Comply with UL 891.

2.3 SEISMIC PERFORMANCE

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 SWITCHBOARDS DESIGN CRITERIA

- A. Front Connected, Front Accessible Switchboard: **[Panel mounted] [Fixed, individually mounted]** main device, panel mounted branches, and sections rear aligned.
- B. Front and Side Accessible Switchboard: Fixed, individually mounted main device; panel-mounted branches; and sections rear aligned.
- C. Front and Rear Accessible Switchboard: Front and rear aligned, with features as follows:
 - 1. Main Devices: **[Fixed, individually]** mounted.
 - 2. Branch Devices: **[Panel] [Fixed, individually] [Panel and fixed, individually] [Fixed and individually compartmented]** mounted.
- D. Nominal System Voltage: As scheduled on Drawings.
- E. Main Bus Continuous Ampere Rating: As scheduled on Drawings.

- F. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls."
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 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."
- G. Enclosure: Steel, NEMA 250, Type [1] [3R].
- H. Enclosure Finish for Outdoor Units: Factory applied finish in manufacturer's standard color, undersurfaces treated with corrosion-resistant undercoating.
- I. Enclosure Finish for Indoor Units: Factory applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- J. Infrared (IR) View Panes: IR transmittance lens secured and sealed to assembly enclosure to allow inspection of electrical transmission components without elevated levels of Personal Protective Equipment (PPE). Locate view panels on [front] [and] [back] of enclosure to allow use of cameras with 2x to 3x horizontal and 1.5x to 2x vertical distance to target with a maximum angle of incidence of 30 degrees to view all 70 volt cable, busbar, and protective device connections within the assembly. Label each window by number, instructions for use, lens material, window transmission rates, and target components; location by clock face method; and baseline emissivity (e.g., "Busbar Connection: 2 o'clock: E = 0.95").
- K. Barriers: Between adjacent switchboard sections.
- L. Insulation and isolation for[**main bus of main section and**] main and vertical buses of feeder sections.
- M. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- N. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- O. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.[**Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.**]
- P. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- Q. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.
- R. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

S. Pull Box on Top of Switchboard:

1. When provided, ensure adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

T. Buses and Connections: Three phase, four wire, unless otherwise scheduled on Drawings.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit breaker line connections.
 - a. If bus is copper, use copper for feeder circuit breaker line connections.
2. Load Terminals: Insulated, rigidly braced, silver plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit breaker positions at full ampere rating of circuit breaker position.
3. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) minimum-size, hard drawn copper of 98 percent conductivity, equipped with pressure 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. Contact Surfaces of Buses: Silver plated.
5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors.
 - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
7. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
8. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.
9. Fire Pump Tap: Provide fire pump tap section in a separate barriered compartment on the line side of the main disconnect(s) and associated bus and tap lugs to feed the fire pump.

U. Busbar Insulation: Factory applied, flame-retardant, tape wrapping of individual busbars or flame-retardant, spray applied insulation. Minimum insulation temperature rating: 105 deg C.

2.5 OVERCURRENT PROTECTIVE DEVICES (OCPDs)

- A. Comply with requirements of Division 26 Section "Protective Devices" for types of OCPDs shown on Drawings. Provide indicated features, ratings, characteristics, and settings.
- B. Future Devices: Where provision for future overcurrent protective devices or space is indicated, equip compartments with mounting brackets, supports, bus connections, and necessary appurtenances, designed for the OCPD types and ampere ratings indicated for future installation of devices.

2.6 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
 3. Control Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.
 4. Current Transformers for Neutral and Ground Fault Current Sensing: Connect secondaries to ground overcurrent relays 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 in compliance with Division 26 Section "Electric Power Management Systems," suitable for three or four wire systems and with the following features:
1. Switch selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
 2. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
- C. Multi-Function Dual/Redundant Programmable Logic Controllers (PLCs): Industrial grade redundant microprocessor-based unit in compliance with Division 26 Section "Electric Power Management Systems", suitable for three or four wire systems and with the following features:
1. Master PLC and online hot backup PLC.
 2. Protective devices, sensors, analog signals and digital network centralized control architecture.
 3. Full Color Human Machine Interface (HMI) Device: Touchscreen LCD display with minimum diagonal viewing area of 15 inches.
 4. Operator shall be able to monitor and control through remote PC per Division 26 Section "Electric Power Management System" (EPMS) the following switchboard screens and functionalities:
 - a. Main Menu: Include date, time, and system status messages with screen pushbuttons to access one-line diagram, system controls, load controls, alarms, bus metering, etc., as required by the installation.
 - b. One-line diagram screen.
 - c. System control screen.
 - d. Alarm summary and historical event capture/report screen.
 - e. Protective device status, settings and loads.
 - f. Protective device individual tripping functions per Division 26 Section "Protective Devices" and "Protective Device Coordination."

- g. Protective device zone selective interlocking (ZSI) functions including ground fault interlocking.
 - h. Bus differential protection.
 - i. **]Key interlock(s) status.]**
 - j. **]Communication and features to meet EPMS system requirements.]**
 - 5. Zone Selective Interlocking (ZSI): Assembly integrated microprocessor based system per Division 26 Section "Protective Devices."
 - D. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.
 - 1. Meters: 4-inch (100-mm) diameter or 6 inches (150 mm) square, flush or semi-flush, with antiparallax 250-degree scales and external zero adjustment.
 - 2. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
 - E. Instrument Switches: Rotary type with off position.
 - 1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
 - 2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.
 - F. Feeder Ammeters: 2-1/2 inch- (64 mm-) minimum size with 90- or 120-degree scale. Meter and transfer device with an off position, located on overcurrent device door for indicated feeder circuits only.
 - G. Watt-Hour Meters: Flush or semi-flush type, rated 5 A, 120 V, 3 phase, 3 wire, with 3 elements, 15-minute-indicating-demand register, and provision for testing and adding pulse initiation.
 - H. Recording Demand Meter: Usable as totalizing relay or as indicating and recording maximum-demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semi-flush mounting.
 - I. Indicating Lights: Shall be mounted on front door of the switchboard, be removable from the front, and shall be General Electric Type ET-5, or Westinghouse Minalite type, complete with low voltage lamp, receptacle, and resistor, suitable for operation from a 120 volt ac source, as required. Fifteen percent (15%) spare lamps and two (2) lamp pullers of the bayonet type shall be provided per switchboard lineup.
 - 1. Red shall indicate open.
 - 2. Green shall indicate closed.
 - J. Relays: IEEE C37.90, "Relays and Relay Systems Associated with Electric Power Apparatus," Types, settings, and control sequences as indicated. Provide test blocks and plugs.
- 2.7 CONTROL POWER
- A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.
 - B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
 - C. Control Power Fuses: Primary and secondary fuses for current limiting and overload protection of transformer and fuses for protection of control circuits.
 - D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.8 RATINGS

- A. Provide nominal system voltage, continuous main bus amperage, and short-circuit current ratings as shown on Drawings. Series ratings of protective devices is not acceptable.

2.9 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Surge Protection Device (SPD): As shown on Drawings and defined in Division 26 Section "Surge Protection for Low Voltage Electrical Power Circuits" for switchboards.
- C. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- D. Rubber Mats:
 - 1. Provide corrugated, nonconductive, rubber mats per Division 26 Section "Hangers and Supports":
 - a. In operating and maintenance aisles on all sides of each electrical assembly.
 - b. As shown on Drawings or otherwise extending the longer of the electrical assembly or associated housekeeping pad and 4 foot minimum width.

PART 3 - EXECUTION – NOT USED

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Utilize isolated ground panelboards for spaces with heavy computer and media requirements.
- B. Provide 20% spare space and capacity in panelboards. Provide space in electrical rooms for future equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. General Panelboards:
 - a. GE Industrial Solutions; a member of ABB Group.
 - b. Square D.
 - c. Eaton Corporation; Cutler-Hammer Products.
 - d. Siemens Energy & Automation, Inc.
 - 2. Integral SPD Electronic Grade Panelboards:
 - a. Current Technology, Inc. – EGPE2 Series.
 - b. L.E.A. Dynatech - MDP Series.
 - c. Liebert - LPG Series.

2.2 REGULATORY REQUIREMENTS

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 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. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

2.3 SEISMIC PERFORMANCE

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 PANELBOARDS, GENERAL REQUIREMENTS

- A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as shown on Drawings. Comply with Division 26 Section "Protective Devices," with OCPDs adapted to panelboard installation. Tandem circuit breakers shall not be used. Multipole breakers shall have common trip.
- B. Supports and Bracing for Buses: Adequate strength of all panelboard components, including OCPDs, for short circuit current ratings as shown on Drawings. The minimum ratings shall be 10,000 AIC for 120/208 volt equipment and 14,000 AIC for 277/480 volt equipment. Series ratings of protective devices shall not be acceptable.
- C. Enclosures: Cabinets, flush or surface mounted as shown on Drawings. NEMA Type 1 enclosure, except where the following enclosure requirements are shown on Drawings. Backboxes shall be made from galvanized steel. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. Provide at least four interior mounting studs with adjustable nuts.
 - 1. NEMA 3R: Raintight.
 - 2. NEMA 3S: Raintight and dust tight.
 - 3. NEMA 4X: Corrosion-resistant fiberglass enclosure, watertight, dust tight, and resistant to oil and coolant seepage.
- D. Front: Secured to box with concealed trim clamps except as indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box except as otherwise specified.
- E. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover. (Exception: Elevator Room fused switch panelboards). Utilize key access, not screws to access the wire elements.
 - 1. If screw type cover needs to be provided, provide hooks at top of enclosure to hold panel cover in place.
- F. Directory Frame: Metal, mounted inside each panelboard door.
- G. Typed directory card completely filled out including "SPARE" and "SPACE" loads.
- H. Bus: Hard drawn, tin-plated copper of 98 percent conductivity.
- I. Main and Neutral Lugs: Compression type.
- J. Main Circuit Breaker (when scheduled): Mounted physically separate from branch breaker lineups (not in same row) to allow for full branch circuit pole quantity.
- K. Branch Circuit Devices: Arranged for double row construction.
- L. Equipment Ground Bus: Adequate for feeder and branch circuit equipment ground conductors. Bond to box with bolted or welded connection.
- M. Gutter: Generally, conform to UL 61.
- N. Service Equipment Approval: Listed for use as service equipment for panelboards having main service disconnect.
- O. Provision for Future Devices: Equip with mounting brackets, bus connections and extensions, and necessary appurtenances, for the OCPD ampere ratings shown on Drawing schedules for future installation of devices.

- P. Special Features: Provide the following features for panelboards as scheduled and or shown on Drawings or as required to meet CEC:
1. Surge Protection Device (SPD): As defined in Division 26 Section "Surge Protection for Low Voltage Electrical Power Circuits" for panelboards.
 2. Isolated Equipment Ground Bus: Adequate for branch circuit equipment ground conductors; insulated from box.
 3. Skirt for Surface-Mounted Panels: Same gauge and finish as panelboard front with flanges for attachment to panel, wall, and floor.
 4. Contactors in Mains: Mechanically held, with current rating, poles, and connections as shown on Drawings. Conform to Division 26 Section "Motor Controllers."
 5. Shunt Trip Control Power Source: Shunt trips where shown on Drawings shall be 120 volt AC. Provide a 120 volt power supply from the main bus with a primary fuse protected, control power transformer, with terminals and wiring for the shunt trip connection to remote pushbutton station(s). Where specified for "emergency" shut-down, install pushbutton on the panel trim. Access to interior shall be without disturbing pushbutton and shall allow for wiring disconnection from pushbutton.
 6. Gutter Barrier: Arranged to isolate section of gutter as shown on Drawings.
 7. Subfeed (Double Lugs): OCPD or lug provisions sized to accommodate feeders shown on Drawings. Provide subfeed lugs for all multi section panelboards. Field install all required cross connection cables.
 8. Feed-Through Lugs: Sized to accommodate feeders shown on Drawings.
 9. Metering: Manufacturers standard devices as shown on Drawings (compatible with metering equipment per Division 26 Section "Electric Power Management Systems.")
 10. Molded Case Switch: Sized to accommodate feeder lugs shown on Drawings.
- Q. Seismic Mounting: On emergency panelboards to allow lateral drifts and restraint design associated with local codes. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls."

2.5 LIGHTING AND APPLIANCE PANELBOARDS

- A. General: Conform to above article "Panelboards, General Requirements" except as follows:
1. Circuit Breakers for Switching Lights at Panelboards: Indicated type SWD.
 2. Circuit Breakers for Equipment Marked HACR Type: Indicated HACR type.
 3. Interiors: Provide physical means to prevent installation of more OCPDs than the quantity for which the enclosure was listed.
 4. Circuit Breakers for Branch Circuits Serving Residential Unit Bedrooms: AFCI circuit breakers per Division 26 Section "Protective Devices."
 5. Main, Neutral, and Ground Lugs and Buses: Have mechanical connectors for conductors.
 6. Branch OCPDs: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
 7. Double-Width Panelboards: Where more than 42 poles are indicated or where otherwise indicated, provide two panelboards bussed together under single front or wired using serving feeder size between panelboards, at Division 26 discretion.
 8. Doors: In panel front, with concealed hinges. Secure with flush catch and cylindrical tumbler lock, all keyed alike. The flush lock shall not protrude beyond the front of the door.

2.6 POWER DISTRIBUTION PANELBOARDS

- A. Doors: Secure with vault-type cylindrical tumbler lock, all keyed alike. The flush lock shall not protrude beyond the front of the door. Doors over 48 inches high hinged, and shall be provided with a vault type handle, built-in locks, and three point latch (top, bottom and center).
- B. Branch-Circuit Breakers: Where OCPDs are shown on Drawings to be circuit breakers, use bolt-on breakers except circuit breakers 225-ampere frame size and greater may be plug-in type where individual positive locking device requires mechanical release for removal.

- C. Motor Starter Branches: Conform to Division 26 Section "Motor Controllers" and provide units equipped for panelboard mounting. Include the following accessories and pilot devices as indicated:
 - 1. Individual control power transformers.
 - 2. Fuses for control power transformers.
 - 3. Pilot lights.
 - 4. Extra interlock contacts.
 - 5. Pushbuttons.
 - 6. Selector switches.
- D. Motor Starter Disconnects: Include overcurrent protection as shown on Drawings. Mount integral with or, in same panelboard, adjacent to motor starter. Mechanically interlock starter door with disconnect device. Provide auxiliary contacts on disconnect to reenergize control connections to starter.
- E. Install metering equipment as shown on Drawings and as per Division 26 Section "Electric Power Management Systems."

2.7 ELECTRONIC GRADE PANELBOARDS SPD CHARACTERISTICS

- A. Include SPD as defined in Division 26 Section "Surge Protection for Low Voltage Electrical Power Circuits" for panelboards.
- B. Conform to above article "Panelboards, General Requirements," except as follows:
 - 1. General:
 - a. 200 Percent Rated Copper Neutral Bus: The unit shall include a 200 percent rated all copper neutral bus designed for the peculiar current demands associated with non-linear loads. The neutral bus shall include AL/CU rated mechanical solderless-type lugs in sufficient quantity and capacity as shown on Drawings.
 - b. Safety Ground Bus: The unit shall include a safety ("equipment") ground bus bonded to the enclosure with connection points equal to the number of branch breaker positions. The safety ground bus shall include AL/CU rated mechanical solderless-type lugs in sufficient quantity and capacity.
 - c. Insulated Isolated Ground Bus: The unit shall include an insulated isolated ground bus with connection points equal to the number of branch breaker positions. The insulated isolated ground bus shall include AL/CU rated mechanical solderless-type lugs in sufficient quantity and capacity.
 - d. Wiring Gutters: The unit shall have an all-around interior perimeter wiring gutter. The cross sectional dimension of the gutter shall be as required by national/local electrical codes but not less than 16 square inches.
 - e. Multiple Sections: For sub-feed or feed-thru lugged multiple section electronic panelboards, each panelboard unit contain all elements listed above except that a single SPD device shall protect the multiple assemblies.

2.8 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: Arranged to permit testing of functions of solid-state trip devices without removal from panelboard.

2.9 IDENTIFICATION

- A. General: Refer to Division 26 Section "Electrical Identification," for labeling materials and methods.
- B. Manufacturer's Nameplate Information:
 - 1. Voltage.
 - 2. Phase.
 - 3. Ampacity.
 - 4. Manufacturer.
 - 5. A.I.C. Symmetrical.
 - 6. UL Listing.
 - 7. Service Entrance Label (as applicable).

PART 3 - EXECUTION – NOT USED

END OF SECTION 262416

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Any deviations to this section shall be reviewed by Project Team during design phase of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Except as otherwise noted, specified, or required, provide each type of wiring device and associated accessories, coverplates, etc., from a single manufacturer.
- B. Acceptable Manufacturers:
1. Bryant Wiring Device Division – Hubbell Incorporated (Bryant).
 2. Cooper Wiring Devices Division – Cooper Industries (Cooper).
 3. Hubbell Wiring Devices/Kellems Division – Hubbell Incorporated (Hubbell).
 4. Leviton Manufacturing Co., Inc. (Leviton).
 5. Pass and Seymour/Legrand (Pass and Seymour).

2.2 GENERAL REQUIREMENTS

- A. Provide wiring devices, in types, characteristics, grades, finishes, colors, electrical ratings listed and labeled, etc., for applications indicated and in compliance with UL and other applicable ANSI and NEMA standards.
- B. Wiring Device Face Colors:
1. General – Except as otherwise noted, provide white device face color with matching color coverplates. Verify color selections with Architect and specialty room finishes.
 2. Wiring device face colors for special application devices, except as otherwise indicated, specified, or required, shall be as follows:
 - a. Receptacles:
 - 1) Connected to CEC Article 700, 701, and 702 Emergency/Standby Systems – Red.
 - 2) Surge Protection Type: Blue face with TVSS graphic ID permanently embossed or engraved thereon.
 - 3) Isolated Ground Type: Grey face with industry standard IG graphic permanently embossed or engraved thereon.
 - b. Switches (Toggle/Actuator Color):
 - 1) Connected to CEC Article 700, 701, and 702 Emergency/Standby Systems: Red.

2.3 REGULATORY REQUIREMENTS

- A. AC Lighting Switches: Quiet type. Comply with UL 20, Fed. Spec. WC-896, and NEMA WD1.
- B. Wall Box Dimmers: Solid state conforming to NEMA WD 1.
- C. Receptacles: Comply with UL 498, Fed. Spec. WC-596, and NEMA WD 1.
- D. Ground-Fault Circuit Interrupter (GFCI) Receptacles:
1. Unless noted otherwise, shall be duplex, 3-wire grounding non feed-thru type, Class A, Group 1, designed, built, and tested per UL Standard 943.

2. Shall be self-testing automatic monitoring type, designed and constructed to automatically monitor and periodically test themselves for their ability to detect a ground fault condition. Upon failure to detect a ground fault condition:
 - a. Device shall automatically trip open, rendering the device "dead-front" (zero voltage or current present at the receptacle face contact points), and simultaneously open the circuit to downstream devices.
 - b. Provide visual indication, at the device face indicating the device can no longer protect against ground fault conditions (end-of-life indication).
 - c. Provide both a visual and an audible indicator at the device face, indicating the device can no longer protect against ground fault conditions (end-of-life indication).
- E. Cord Style Plug Connectors: 20 amperes, 125-volts, nylon body connectors, 3-wire, grounding, parallel blades, double wipe contact, with cord clamp, cord hole. Match NEMA configuration to mating plug. Arrange as shown on Drawings.

2.4 WIRING DEVICE PIGTAIL CONNECTOR OPTION

- A. At Contractor's option, but subject to other requirements of this Section, UL 2459 listed pigtail style modular connectors designed, fabricated, and tested for use with stranded branch circuit conductors may be provided to allow:
 1. Rough-in of pre-stripped 6 inch leads to a connector.
 2. Modular plug-in to the wiring device.
 3. Basis of Design:
 - a. Bryant - Quick-Tech™.
 - b. Cooper - ArrowLink™.
 - c. Leviton - LEV-LOK™.
 - d. Hubbell - Snap Connect™.
 - e. Pass and Seymour – Plug Tail™.

2.5 AC LIGHTING SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Standard toggle handle specification grade back and side wired: (*Indicates single pole, double pole, 3-way or 4-way, as required):
 - a. 20 amp, 120-277 volt:
 - 1) Bryant - 490* Series.
 - 2) Cooper - AH122* Series.
 - 3) Hubbell - HBL122* Series.
 - 4) Leviton - 122*-2 Series.
 - 5) Pass and Seymour - PS20 AC* Series.
 2. Key operated, 20 amp, 120-277 volt, specification grade, back and side wired. (* Indicates single pole, double pole, 3-way or 4-way, as required.):
 - a. Slotted face, with removable fork style key:
 - 1) Bryant – 490* LI Series.
 - 2) Cooper – AH122* L Series.
 - 3) Hubbell – HBL122* L Series.
 - 4) Leviton – 122* L Series.
 - 5) Pass and Seymour – PS20AC* L Series.

3. Dimmable Button Switches:

- a. Shall be rated 20A @ 120VAC and 277VAC, provided as single pole, 3-way, or 4-way operating devices, as indicated.
- b. Shall be provided with up and down buttons operating dimming style control devices.
- c. Coverplate shall attach to device with no exposed fasteners.
- d. Shall be designed, fabricated and tested for installation within a single, gang electrical outlet box opening and shall be specifically designed for multi-gang installations, matching the look, appearance and operating motion of adjacently installed dimming style control devices.
- e. Acceptable Manufacturers:
 - 1) Lutron Electronics, Inc. – Maestro or Caseta Series (*indicates single pole, 3-way or 4-way operation, as indicated).
 - 2) Or equivalent.

2.6 LINE VOLTAGE WALL BOX DIMMERS

A. LED:

1. 3-Wire Up/Down Button Type:

- a. Shall be solid state electronic, electro-mechanical devices, with buttons, suitable for use, and compatible with the procured 3-wire LED drivers.
 - 1) UP movement of actuator turns connected load ON.
 - 2) UP/DN buttons raises/lowers lighting intensity.
 - 3) DN press movement to lowest position turns connected load OFF.
- b. Shall be rated to control not less than the following dimmable LED lighting load:
 - 1) 16A @ 120VAC.
 - 2) 8A @ 277VAC.
- c. Provide as single pole or 3-way multi-location control devices as indicated.
- d. Shall be semi-flush, thin profile design, with no exposed heat sink fins, designed fabricated and tested for installation within a single gang electric box opening.
- e. Linear slide actuating device shall provide a positive mechanical air gap type branch circuit disconnecting means at the bottom travel OFF position.
- f. Faceplate Finish/Color: Nylon/White. Actuator Finish/Color: Nylon/White.
 - 1) Faceplate shall attach to device with no exposed fasteners.
- g. Acceptable Manufacturers:
 - 1) Lutron Electronics, Inc. - Maestro or Caseta Series.
 - 2) Or equivalent.

2. 0-10V Dimmer Type:

- a. Shall be electronic, low voltage, solid state devices, with button style dimming actuator, suitable for use and compatible with 0-10V LED drivers.
 - 1) UP/DN press action raise/lower actuator.
 - 2) ON/OFF control shall be initiated by the device, via a remote, separately installed power supply/control unit with integral switching relay.
 - 3) Press to lowest position shall initiate OFF command to separately installed power supply/control unit.

- b. Shall, in combination with the remote power supply/control unit switching relay, control not less than 16A of dimmable LED driver lighting load @ either 120 or 277VAC.
 - c. Provide as single pole and electronic, multi-location control devices as indicated.
 - d. Faceplate Finish/Color: Nylon/White. Actuator Finish/Color: Nylon/White.
 - 1) Faceplate shall attach to device with no exposed fasteners.
 - e. Provide complete with separately installed power supply/control unit. Power supply/control unit shall be:
 - 1) A combination device providing 24VDC (100 mA) output from an input of either 120 or 277VAC input, to remotely connected devices.
 - 2) Provided with an integral switching duty relay, rated to interrupt not less than 16A @ either 120 or 277VAC.
 - 3) Enclosed in a high impact, molded, thermoplastic housing, designed for field installation within or to a standard electrical outlet box.
 - f. Acceptable Manufacturers:
 - 1) Lutron Electronics, Inc. - Mastro Series Dimmer and PP-120/ 277H Power Supply/Control Unit.
 - 2) Or equivalent.
3. Electronic Low Voltage (ELV) Button Type:
- a. Shall be electronic, low voltage, solid state devices, with button style dimming actuator, suitable for use, and compatible with, electronic low voltage (ELV) reverse phase LED drivers.
 - 1) UP/DN press action raise/lower actuator.
 - 2) ON/OFF control shall be initiated by the device, via a remote, separately installed power supply/control unit with integral switching relay.
 - 3) Press to lowest position shall initiate OFF command to power supply/control unit.
 - b. Shall, in combination with the remote power supply/control unit switching relay, control not less than 16A of dimmable LED driver load @ either 120 or 277VAC.
 - c. Provide as single pole or electronic, multi-location control devices as indicated.
 - d. Faceplate Finish/Color: Nylon/White. Actuator Finish/Color: Nylon/White.
 - 1) Faceplate shall attach to device with no exposed fasteners.
 - e. Provide complete with a separately installed power supply/control unit. Power supply/control unit shall be:
 - 1) A combination device providing 24VDC (100 mA) output from an input of either 120 or 277VAC input, to remotely connected devices.
 - 2) Provided with an integral switching duty relay, rated to interrupt not less than 16A @ either 120 or 277VAC.
 - 3) Enclosed in a high impact, molded, thermoplastic housing, designed for field installation within or to a standard electrical outlet box.
 - f. Acceptable Manufacturers:
 - 1) Lutron Electronics, Inc. - Dimmer and PP-120/ 277H Power Supply/Control Unit.
 - 2) Or equivalent.

2.7 GENERAL PURPOSE RECEPTACLES

- A. Standard Face - 20 amp, 125 volt, straight blade, NEMA 5-20R, duplex grounding type:
1. General Purpose - Heavy duty, premium specification grade, with brass strap:
 - a. Bryant – N/A.
 - b. Cooper – AH5362 Series.
 - c. Hubbell - HBL5362 Series.
 - d. Leviton – 5362 Series.
 - e. Pass and Seymour – 5362A Series.
 2. Controlled Receptacle – Shall be the General Purpose receptacle specified above, with additional CEC compliant marking, permanently applied to the face, identifying the receptacle as being "controlled". Face color shall be green match face color of other receptacles, as specified.
 3. Isolated Ground Type – Heavy duty, premium specification grade. grey] color face:
 - a. Bryant – BRY5462IG Series.
 - b. Cooper – IG5362 Series.
 - c. Hubbell – IG5362 Series.
 - d. Leviton – 5362IG Series.
 - e. Pass and Seymour – IG5362 Series.

2.8 SPECIAL PURPOSE WIRING DEVICES

- A. Combination AC/DC USB Charging Type Receptacles:
1. Duplex NEMA 5-20R, 20 amp, 125 volts, tamper resistant, 3-wire grounding type AC receptacle, and two 5 VDC USB 2.0 compatible Type C ports factory assembled on a common, single gang wiring device strap. Shall provide USB shutoff circuitry to automatically stop charging when the connected device is fully charged.
 - a. Bryant - USBB20 Series.
 - b. Cooper – TR7746 Series.
 - c. Hubbell - USB 20X2 Series.
 - d. Leviton - T5832 Series.
 - e. Pass and Seymour – TR5362 USB Series.
 2. Only use in lounge student gathering areas above counters or near seating. Be aware of tripping hazards. Do not install in classrooms. Coordinate with design team prior for final layout locations.
- B. Pilot Lights: Faceted, red translucent plastic lens translucent plastic lens, conforming to toggle switch handle shape, with neon gas or LED light source behind lens, factory assembled onto a single gang wiring device strap, rated for 120/277 VAC operation.
1. Pass and Seymour – 2151RED.
 2. Or equivalent.
- C. Electric Range Receptacles - 50 amp, 250 volt, 3 pole, 4 wire, heavy duty, straight blade, flush installation, NEMA 14-50R:
1. Hubbell – 7962.
 2. Leviton – HBL 5206.
 3. Pass and Seymour – 3890.
- D. Electric Dryer Receptacles - 30 amp, 125/250 volt, heavy duty specification grade, grounding straight blade type, NEMA 14-30 for flush installation:
1. Hubbell – HBL 9430.

2. Leviton – 278.
 3. Pass and Seymour – 3864.
- E. Clock Hanger Style Receptacle – Single, 15 amp, 125 volt, specification grade, 3-wire grounding, straight blade, NEMA 5-15R, receptacle, stainless steel coverplate, integral clock hanging hook:
1. Hubbell – HBL 5235.
 2. Leviton - 5261-CH.
 3. Pass and Seymour - S-3733-SS.
- F. Boiler/Chiller Emergency Shut Down Station:
1. One N.O. and one N.C. switched contact device, rated 3A per contact @ 600 VAC, and 1A per contact @ 250 VDC, factory installed on a stainless steel backplate assembly.
 2. Actuator shall be momentary contact mushroom head style, fabricated from polycarbonate material, red in color, regressed back from station cover, with the word "PUSH" permanently embossed in face, with white filled letters.
 3. Station cover shall be fabricated from molded polycarbonate material, red in color, with the words "BOILER SHUT DOWN", or "CHILLER SHUT DOWN", permanently embossed in face, with white filled letters.
 4. Referenced Product:
 - a. Safety Technology International, Inc. – STI Series 2000.
 - b. Or equivalent.
- G. Emergency Power Off (EPO) Station:
1. Heavy duty momentary contact red pushbutton with guard, flush stainless steel plate. Provide four (4) sets of contacts **[minimum]** allowing four (4) independent shunt trip panelboards per lab, and special backbox as required. Nameplate per Division 26 Section "Electrical Identification" requirements.
 2. Allen Bradley, General Electric, Cutler Hammer - Westinghouse, Square D, or Siemens Allis.
- H. Electrical Cord Reels:
1. Construction:
 - a. Steel, maximum 14 inch diameter reel, with ceiling mounting base and load cord guide arm ball stop base. Heavy Duty construction.
 - b. Reel, base, and guide arm ball stop base color white or as selected by Architect.
 - c. Above ceiling mounting plate to match weight capacity for supporting the device.
 - d. Raceway to cord reel shall be supported at a minimum of two locations near reel location (vertical to structure above or angled).
 2. Electrical:
 - a. General:
 - 1) UL 355 listed.
 - 2) Line: Minimum 5 foot length, 3 conductor, 20A, 120 VAC black supply cord with NEMA 5-20P twist-lock plug.
 - 3) Load: Minimum 25 foot length, 3 conductor, 12 AWG white SJ cord, with adjustable ball stop and stress relief connected outlet box with two duplex NEMA 5-20R receptacles to match requirements of Division 26 Section "Wiring Devices". Manually retractable cord ratchet with positive lock engagement, constant tension disengagement for manual cord length adjustability.
 - 4) Outlet box color white or as selected by Architect.

- b. Special voltage and configurations as shown on Drawings.
 - 3. Manufacturers:
 - a. CoxReels PC13-5012-B Series.
 - b. Duro Reel Technology 2503-E Series.
 - c. Hubbell HBL4512R Series.
 - d. KH Industries RTB Series.
 - e. Reelcraft L4545-123-7X Series.
- 2.9 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES
- A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
 - 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. Cooper Crouse-Hinds.
 - b. EGS/Appleton Electric.
 - c. Killark; Division of Hubbell, Inc.
- 2.10 TWIST-TO-LOCK RECEPTACLES
- A. Single Receptacles, 125 volt, 20 amp: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; CWL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass and Seymour; L520-R.
 - B. Isolated-Ground Receptacles, 125 volt, 20 amp:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; IGL520R.
 - b. Hubbell; IG2310.
 - c. Leviton; 2310-IG.
 - d. Pass and Seymour; IG4700.
 - 2. Description:
 - a. Comply with NEMA WD 1, NEMA WD 6, Configuration L5-20R, and UL 498.
 - b. Grounding contact shall be connected only to the grounding screw terminal of the device and shall be provided with inherent electrical isolation from the device mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- 2.11 PENDANT CORD-CONNECTOR DEVICES
- A. Description:
 - 1. Matching, locking-type plug and receptacle body connector.
 - 2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.

3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.12 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.13 WIRING DEVICE ACCESSORIES

A. Indoor Coverplates:

1. General: Unless noted, shown, or otherwise indicated, provide to match the associated wiring device(s) configuration, style, and ganging.
 - a. Provide single, multi-gang, and combination coverplates as required, specified, or otherwise indicated, to match the installed wiring device(s) configurations, and ganging.
2. Provide with metal screws for securing coverplates to device(s), with screw head color to match.
 - a. Exception: Provide non-metallic, or non-ferrous coverplates and screws, over wiring devices installed in MRI suites.
3. Materials and Finishes:
 - a. Stainless Steel: Type 302, satin smooth finish, square corners, beveled edges.
 - 1) Coverplates with rounded corners and no bevel do not meet this specification.
4. Colors – Unless noted, shown, or otherwise indicated:
 - a. Coverplates for wiring devices connected to the "normal" power electrical distribution system shall be:
 - 1) Stainless Steel – as specified above.
 - b. Coverplates for wiring devices connected to CEC Article 700, 701, and 702 Emergency System branch circuits shall:
 - 1) Be red – with ID per Division 26 Section "Electrical Identification."
 - 2) Match the coverplate color/finish previously specified for "normal" power system wiring devices, with ID per Division 26 Section "Electrical Identification."
 - c. Where multiple devices, potentially connected to multiple electrical distribution system branch circuits, with multiple wiring device face colors, are installed under a common coverplate, the coverplate color/finish shall be the color/finish specified for the "normal" power branch circuit wiring device color.
5. For wiring devices installed in utilitarian spaces over surface mount outlet boxes, provide steel, wraparound, utility type outlet box covers.

6. Acceptable Manufacturers:
 - a. By wiring device manufacturer.
- B. Indoor High Abuse Coverplates (suffix HA):
 1. Shall be a two-part device consisting of a backplate/wall anchor and a heavy cast device coverplate.
 - a. Backplate/wall anchor shall be fabricated from not less than 12 GA galvanized sheet steel, with threaded holes to accept device coverplate and for outlet box attachment.
 - b. Device coverplate shall be fabricated from heavy wall (not less than .125 inch thickness), corrosion resistant, die cast zinc.
 - c. Device coverplate shall be radius face design, with appropriate device cutout, such that installed device will be regressed back from face after installation.
 - d. Coverplate shall be fastened to backplate with tamper resistant, stainless steel screws regressed into face of coverplate.
 2. Acceptable Manufacturers:
 - a. Morelite – CSWP Series.
- C. Outdoor/Wet Location Coverplates:
 1. For switches installed outdoors, and switches installed indoors in wet locations, and switches indicated or noted with suffix "WP"; provide gasketed, weathertight cast, copper-free aluminum coverplates, with cast aluminum, lever arm style switch actuators, in corrosion resistant, epoxy paint finish, furnished complete with gasketing and stainless steel screws.
 - a. Acceptable Manufacturers:
 - 1) Design Equipment: Crouse-Hinds – DS185.
 - 2) Equivalents: Appleton Electric, Killark Elec. Mfg. Co.
 2. For receptacles installed outdoors, and receptacles installed indoors in wet locations, and receptacles indicated or noted with suffix "WP" provide gasketed, weathertight, cast aluminum, corrosion-resistant, wet location, outlet box covers, UL listed "Suitable for Wet Locations While in Use."
 - a. Shall be rated NEMA 3R while in use, provided complete with closed-cell foam gasket, and shall be provided with padlocking provision.
 - b. Shall be fabricated from die-cast aluminum alloy A360, with less than .004 copper content (copper free), provided with a factory applied aluminum lacquer finish. Vandal proof box
 - c. Provide size and configuration with intended use of receptacle.
 - d. Secure backbox to structure. Do not utilize toggle bolts.
 - e. Acceptable Manufacturers:
 - 1) Design Equipment: Thomas & Betts – "Red Dot" Code Keeper Series.
 - 2) Pass and Seymour - WIU Cast Series.
 - 3) Or equivalent, submitted for approval.
- D. Wire Guards (Use designated by subscript "WG" as shown on Drawings):
 1. Requirement: Consistent application on project for physical protection of devices by heavy duty steel cage design. Cage shall not impede proper device operation and shall be screw mounted with appropriate hardware over device.
 - a. Thermostat locations shall have hinged cover.
 2. Finish: White polyester coating corrosion resistant clear finish over bright metal "chrome"].

3. Special Finish for Equipment Rooms or Exterior: Corrosion resistant, white polyester coating.
4. Submittals shall include product information (and samples) for each device application.
5. Acceptable Manufacturers:
 - a. Safety Technology International, Inc. (STI).
 - b. S.E.C, Inc.
 - c. Space Age Electronics, Inc. (SAE).
 - d. Device manufacturers' standard wire guard product if compatible with other project wire guards.

2.14 RECEPTACLE TESTER

- A. Manual, solid-state insulated thermo-plastic testing device, with a 3 prong NEMA 5-15P plug on one end, that when inserted into a NEMA 5-15R or 5-20R receptacle, will provide visual diagnostic test results. Device shall provide not less than the following test parameters:
 1. Correct Receptacle Wiring: Open ground, reverse polarity, open not, open neutral, hot/neutral reverse.
 2. GFCI Receptacle Proper Function: Test for proper GFCI operation.
- B. Referenced Product:
 1. Ideal Industries, Inc. - Model 61-501.
 2. Or equivalent.

PART 3 - EXECUTION – NOT USED

END OF SECTION 262726

SECTION 262800 - PROTECTIVE DEVICES

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 THERMAL-MAGNETIC MOLDED CASE CIRCUIT BREAKERS

- A. Manufacturers:
 - 1. GE Industrial Solutions; a member of ABB Group.
 - 2. Square D/Group Schneider.
 - 3. Eaton Corporation; Cutler-Hammer Products.
 - 4. Siemens Energy & Automation, Inc.
- B. Construction:
 - 1. Tripping Mechanisms: Inverse time delay thermal element for long-time overload tripping and an instantaneous magnetic trip element set to operate at 7 to 10 times the long-time trip setting for high fault current tripping in each phase. Common trip for multiple breakers without the use of handle ties. Trip-free over center quick-make, quick-break switching mechanism shall provide distinctive handle positions to self-indicate automatic tripping.
 - 2. Enclosure: Bakelite, epoxy, glass-fibered reinforced polyester or similar material required to obtain interrupting rating.
 - 3. Mounting: Plug-in for assembly rated 14,000 amperes interrupting capacity or below; bolt-in otherwise. Rating labels shall be visible when breaker is installed.
 - 4. Terminal Lugs: Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connections.
- C. Ratings:
 - 1. Trip: As scheduled.
 - 2. Frame: Provide as scheduled as minimum requirement.
 - 3. AIC: Provide as scheduled as minimum requirement.
- D. Special Features: Interchangeable trip settings, shunt trip, undervoltage trip, bell alarm, auxiliary switch, motor operator, etc., as shown on Drawings.
 - 1. Molded case switch shall have manual only tripping mechanism.

2.2 SOLID-STATE MOLDED CASE CIRCUIT BREAKERS

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. GE Industrial Solutions; a member of ABB Group.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D/Group Schneider.

B. Construction:

1. Standard Tripping Mechanism: Solid-state tripping elements with associated current monitor and flux transfer shunt trip in two or three pole applications. Sensors shall be provided for each pole. Long-time trip settings shall be adjustable using rating plug and dials covering a minimum range of 50 – 100 percent of the specified rating. Hand held battery operated programmers are acceptable; however, provide a minimum of (2) programmers, a wall mountable galvanized steel storage box and provide a minimum of (2) 4 hour additional training sessions for the Owner. The magnetic trip unit shall have adjustable short-time and instantaneous trip characteristics. Trip unit shall be common for all poles, trip-free, over center quick-make quick-break switching and consist of a manual trip button and trip indicators. The trip device shall be insensitive to temperature changes between minus 20 degrees C and plus 55 degrees C. The long-time delay, short-time pickup, short-time delay and instantaneous pickup shall be fully adjustable using dials[, **Electric Power Management System integration,**] or a hand held programmer, with the following minimum characteristics, based on the coordination study, settings and adjustments may override specification generalities:
 - a. Long-time pickup (0.5 – 1) x plug rating.
 - b. Long-Time Delay:
 - 1) 600 amps and below (2-14 seconds).
 - 2) Above 600 amps (2-24 seconds).
 - c. Short-time pickup (2-8) x plug rating.
 - d. Short-Time Delay:
 - 1) 600 amp frame and below (0.1 – 0.2 seconds) including $I^2 t$ out/in.
 - 2) 800 – 1600 amp frame (0.1 - 0.4 seconds) including $I^2 t$ out/in.
2. Ground Fault Protection Tripping: Shall utilize the flux transfer shunt trip. Utilize an internal sensor for breakers equal or under the 400 amp frame rating. Above 400 amps, the ground fault trip shall be a self-contained external relay and shunt trip, except for neutral sensor, and feature an adjustable pick-up and time delay range from 0 to 18 cycles. Sensing shall be by the residual current method. Provide trip indicator and test panel.
 - a. Ground Fault Pickup:
 - 1) 1200A or Below: 0.2 - .7 times.
 - 2) Above 1200A: 500A – 1200A.
 - b. Ground Fault Delay:
 - 1) 600 amp frame and below (0.1 – 0.2 seconds) $I^2 t$ on/off.
 - 2) 800 – 1600 amp frame (0.1 – 0.4 seconds) including $I^2 t$ on/off.
3. Enclosure: Bakelite, epoxy, glass-fibered reinforced polyester or similar material required to obtain interrupting rating. Provide sealable tamperproof cover over adjustment controls.
4. Mounting: Bolt-in.
5. Terminal Lugs: Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connection.

C. Ratings:

1. Trip: As scheduled.
2. Frame: Provide as scheduled as minimum requirement.
3. Sensor-Clip shall match frame size.
4. AIC: Provide as scheduled as minimum requirement.

- D. Special Features: Interchangeable trip settings, shunt trip, undervoltage trip, bell alarm, auxiliary switch, motor operator, etc., as shown on Drawings.

1. Molded case switch shall have manual only tripping mechanism.

2.3 INSULATED CASE CIRCUIT BREAKERS

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products – SB Series.
2. GE Industrial Solutions; a member of ABB Group – JP/TC or THP/THC Series.
3. Siemens Energy & Automation, Inc. – SE Series.
4. Square D/Group Schneider.

B. Construction:

1. Tripping Mechanisms: Solid-state tripping elements with associated current monitors and two step stored energy tripping with manual (electrical) charging mechanism for closing springs which automatically charge the opening springs during operation. Closing shall be within 5 cycles for generator synchronization and at lower cycles to protect switchboards not rated above the breaker cycle with standard rating. Manual tripping shall be accomplished by a mechanical push-button. Long-time trip settings shall be interchangeable with removable rating plugs.
2. Sensors: Static sensors in each pole shall have adjustments for:
 - a. Long-time pick-up (5 points minimum).
 - b. Long-time delay (3 bands minimum).
 - c. Short-time pick-up (5 points minimum).
 - d. Short-time delay (3 bands minimum).
 - e. Instantaneous pick-up (6 points minimum).
3. Indicators: Shall show status and conditions for:
 - a. Breaker position.
 - b. Stored energy charging system status.
 - c. Instantaneous trip.
 - d. Overload trip.
4. Ground Fault Protection Tripping: Shall have necessary internal and/or external sensors and feature an adjustable pick-up (3 points minimum) and time delay (3 bands minimum) range from 0 to 18 cycles. Provide trip indicator and test panel.
5. Enclosures:
 - a. Encased: Glass-reinforced thermostat polyester.
 - b. Metal enclosed with arc-extinguishing chutes.
6. Mounting: Fixed . Provide interlocks to insure breaker is open before it can be moved to any position. Include an interlock to discharge the stored energy spring before breaker can be withdrawn from cell. In the test and connected positions, provide a positive ground contact between breaker element and the structure. Furnish padlocking provisions for up to 3 padlocks when the breaker is in the open position which positively prevents unauthorized closing of the breaker contacts.
7. Terminal Lugs: Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connection.
8. Contacts and Front Entrance Cover Indicating Lights: Suitable for "Breaker Open" and "Breaker Closed" for main and bus tie breakers, and for other indicated breakers.

C. Ratings:

1. Trip: As scheduled on Drawings.

2. Frame: Provide as scheduled as minimum requirement.
3. AIC: Provide as scheduled as minimum requirement.

2.4 FUSED CIRCUIT BREAKERS

- A. Circuit breaker fuse combinations. If breakers can meet ratings without fuses, this will be acceptable. Conform to the requirements of this section for circuit breakers and trip devices and comply with the following additional specifications:
 1. Fuses: NEMA Class current limiting types that coordinate with and protect the associated circuit breaker.
 2. Breakers of 1,600 Amps Frame Size and Smaller: Install fuses on line side of associated circuit breaker on a common drawout mounting.
 3. Breakers with Frame Sizes Over 1,600 Amps: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Interlock the fuse drawout element with the associated power circuit breaker to prevent drawing out the fuse element unless the breaker is in the open position.
 4. Interrupting Capacity: 200,000 RMS amperes symmetrical at rated voltage and frequency.
 5. Open Fuse Trip Device: Positive means of tripping and holding the associated circuit breaker in the trip-free or locked-out position when a fuse opens until each open or missing fuse is replaced. Provide positive identification of an open fuse at the front of the circuit breaker.
- B. Special Features: Ground fault tripping, current limiting plugs, shunt trip, undervoltage trip, bell alarm, auxiliary switch, operation counter, key interlocks, etc., as shown on Drawings.

2.5 ARC FAULT CIRCUIT INTERRUPTER (AFCI) CIRCUIT BREAKERS

- A. Manufacturers:
 1. Eaton Corporation; Cutler-Hammer Products.
 2. GE Industrial Solutions; a member of ABB Group.
 3. Siemens Energy & Automation, Inc.
 4. Square D/Group Schneider.
- B. Definition - Arc Fault Circuit Interrupter: A device intended to provide protection against the effects of arcing faults by recognizing characteristics that are unique to arcing fault conditions and by functioning to de-energize a circuit when an arcing fault occurs.
- C. Construction:
 1. Standard tripping mechanism per UL 1699:
 - a. Single pole AFCI breaker for 120 VAC, single phase applications.
 - b. Two pole, AFCI breaker with common trip is applied in 3 wire, 120/240 VAC and 240 VAC applications.
 - c. Two pole independent trip for 120 VAC multi-wire applications with a shared neutral.
 - d. A combination AFCI/GFCI breaker shall be utilized for applications where AFCI protection and 5 ma GFCI protection are required.
 - e. All AFCI breakers shall be HACR rated and SWD rated for 15 and 20 amperes.

2.6 DISCONNECT SWITCHES

- A. General:
 1. Disconnect switches for 120 VAC equipment shall be manual fractional horsepower motor controllers, as specified in Division 26 Section "Motor Controllers," with engraved coverplate identifying load served.
 2. Other disconnect switching shall be as specified below.

B. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

C. Construction:

1. Heavy duty type, fused and/or non-fusible as shown on Drawings.
2. Interior Construction: Switch blades fully visible in the off position when the enclosure door is open. Fuseholders for specified fuse, rejection type.
3. Switch Mechanism: Quick make, quick break with positive interlock to prevent opening of enclosure door when operating handle is in the on position and to prevent closing of the switch mechanism with the door open. Operating handle shall be an integral part of enclosure base, have provisions for three padlocks in the off position, and the means to indicate whether the switch is on or off by its position. Vertical operating handles shall be up in the on position.
4. Terminal Lugs: Suitable for quantity of wire to be attached, front removable with terminal shields; mechanical type for copper wire, compression type for aluminum wire.

D. Ratings:

1. Amperes: 30 - 1200.
2. Voltage: 240 or 600.
3. Poles: 2, 3, or 6.
4. AIC: Match fuse or upstream protective device.
5. Horsepower Rated: 30 - 600 amps.

E. Enclosure:

1. Surface mounted type.
2. Type shall suit area per NEMA requirements.
3. Ground wire lug of suitable size shall be brazed to the enclosure. Neutral bar on four wire systems shall be ungrounded.
4. Nameplates on front shall identify load service as well as proper fuse application warning.

F. Special Features: Service entrance rated, control circuit interlock, etc., as shown on Drawings.

1. Label each safety switch per Division 26 Section "Electrical Identification," with the following legend in capital lettering at least 3/8 inch high: "DANGER, DO NOT START OR STOP MOTOR WITH THIS SWITCH. USE FOR ISOLATION ONLY."
2. Where indicated (by subscript "AUX") provide not less than one set of Form C (1 N.O & 1 N.C) auxiliary contacts, mechanically interlocked to the switch operating handle, such that the N.C. contact opens prior to the switch blades closing, of the N.O. contact closes prior to the switch blades opening.
 - a. Contacts shall be rated not less than 15A continuous, @ 240 V AC.

2.7 BOLTED PRESSURE CONTACT SWITCHES

A. Make: Square D, General Electric (a member of ABB Group), Eaton-Pringle Division.

B. Construction:

1. Heavy Duty type, fused and/or non-fusible as shown on Drawings.
2. Operator: Front mounted switch.

3. Tripping Mechanism: Field adjustable ground fault trip and time delay with no trip test button and indicator. Tripping mechanism shall be by electric trip unit powered by a solenoid connected via a control transformer to two phases on the line side of the switch. Tripping mechanism shall also be triggered by a phase failure relay.
4. Fuseholders: For Class L fuses only.
5. Terminal Lugs: Suitable for type of cable or bus to be attached.
6. Configuration: Upright.
7. Enclosure - Sheet steel to form integral part of switchboard(s).
or
 - a. Surface mounted type.
 - b. Type shall suit area per NEMA requirements.
 - c. Ground wire lug of suitable size shall be brazed to the enclosure. Neutral bar on four wire systems shall be ungrounded.
8. Nameplates: Provided to identify as "main" or load serviced as well as proper fuse application warning.
9. Accessories: As shown on Drawings.

C. Ratings:

Rated Voltage	Ampere Ratings	Fusible AIC	Manufacturer Type		
			Sq. D	GE	Pringle
208/240	3000	100K			GA-ET
480/600	3000	200K	BLG-34	THPC	GA-ET

- D. Special Features: Service entrance rated, control circuit interlock, etc., as shown on Drawings.

2.8 FUSEHOLDERS

- A. Provide fuseholders to accommodate the fuses specified. Coordinate installation with assembly manufacturers as applicable.
1. Terminal Lugs: Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connection.

2.9 ZONE SELECTIVE INTERLOCKING (ZSI) SYSTEM

A. General:

1. Assembly integrated microprocessor based system providing communication between main and feeder breakers to insure fast feeder breaker clearing of downstream instantaneous region disturbances (short circuit or ground fault conditions) without nuisance tripping of the main breaker.

B. Function:

1. Feeder breaker closest to the fault will ignore its preset short time and ground fault delays and open to clear the fault with no intentional delay. Other branch and main protective devices will be restrained; remain closed to maintain service to unaffected loads via the communication link.

C. Application:

1. Required for enhanced coordination or reduced arc flash category as indicated or as defined by the coordination study results of Division 26 Section "Protective Device Coordination."

2. Required as a component of indicated Arc Flash Protection Systems.

2.10 ARC FLASH PROTECTION SYSTEM (AFPS)

- A. General: Assembly integrated microprocessor based system with the following features:
- B. Function:
 1. Manually set assembly adjustable protective devices to instantaneous trip "AFPS" mode with no time delay [**or zone protective interlocking**] thus defeating system protective device coordination to minimize arc flash incident energy. This theoretically allows assembly maintenance or troubleshooting to be more safely performed by qualified personnel with the assembly energized.
 2. Manual reset to "normal" mode with 15 second delay shall reset protective device time delay trip settings per coordination study. The delay is to allow personnel to leave the area in front of equipment. Assure backup electronic storage of normal protective device settings which can be automatically downloaded to device.
- C. Manual AFPS-Normal Switch:
 1. Dedicated switch located on front of assembly.
 2. Local or integral to switch pilot lights shall indicate operating modes.
- D. Rotating Beacon:
 1. Mount rotating industrial grade amber beacon on top of each assembly to remind personnel that AFPS system is activated. AFPS mode trip settings shall be verified prior to beacon activation through a feedback control function.
- E. Power Supply:
 1. Manufacturer standard with control transformers integral to associated assembly.
- F. Identification:
 1. Assembly AFPS switch identification, switch AFPS and normal mode, and appropriate warning labels shall be engraved laminated acrylic or melamine label type as specified in Division 26 Section "Electrical Identification."

2.11 KEY INTERLOCKS

- A. General:
 1. Mechanical keyed protective device shall enhance electrical safety to permit sequencing of switching type protective devices with other keyed switching devices or enclosures. Specific functionality and sequencing shall be per assembly specifications and as shown on Drawings. Note that multiple keys may be required for some single safe operation sequence applications.
 2. All keys shall remain captured in the frame except when the switching type protective device has been locked in the OPEN position when a brass mechanical slip bolt has been extended to prevent closure.
 3. Key type shall be assembly specific and shall not be compatible with associated assembly door interlock and padlock devices. Keys shall be engraved with identifying number. One spare set of keys per assembly shall be turned to Owner and shall be properly mounted in a lockable NEMA 1 cabinet per Division 26 Section "Boxes and Cabinets". Identify KEY INTERLOCK SPARES per Division 26 Section "Electrical Identification."
 4. Padlocking in lieu of slip bolt type key interlocks is not acceptable.
 5. The lock assemblies shall be securely mounted to enhance safety.
- B. Make: As recommended by assembly manufacturer.

2.12 ACCESSORIES

- A. Provide breaker accessories for general operation and maintenance of specified breakers. Include items listed below and items recommended by manufacturer:
 - 1. Test kit for each type of solid state, and power air breaker.
 - 2. Handle extensions for low voltage devices 1200 amperes and larger.
 - 3. Three (3) spare adjustable trip plugs for each rating specified.
 - 4. Special adjustment tools.
- B. Provide, in a surface wall mounted cabinet, per Division 26 Section "Boxes and Cabinets", three (3) spare fuses of each size and type utilized on the project neatly arranged in clips or holders. Provide SPARE FUSES cabinet nameplate centered on front.
- C. Provide quantities of circuit protective accessories in locations necessary for effective general operation.
- D. Provide breaker handle clips in on position at all breakers serving fire alarm equipment. Include equipment identification label "Fire Alarm System" at breaker per Division 26 Section "Electrical Identification."
- E. Fire pump feeder breakers and disconnects shall have provision to padlock operating handle in on position.

PART 3 - EXECUTION – NOT USED

END OF SECTION 262800

SECTION 262913 - MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Variable frequency drives are preferred.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Group, ABB Power Distribution, Division.
 - 2. Eaton Corporation; Cutler-Hammer Products.
 - 3. GE Industrial Solutions, a member of ABB Group.
 - 4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
 - 5. Siemens/Furnas Controls.
 - 6. Square D.

2.2 REGULATORY REQUIREMENTS

- 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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

2.3 SEISMIC PERFORMANCE

- A. Seismic Performance: Motor controllers shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 MOTOR CONTROLLERS, GENERAL

- A. Controller shall be manual type for motors 1/3 HP and smaller and magnetic type for motors 1/2 HP and larger.
- B. All controllers for motors 5 HP and larger shall be equipped with capacitors connected to the load side terminals to correct power factor to between 0.95 and 0.99 at no load conditions.
- C. Coordinate the features of each motor controller with the ratings and characteristics of the supply circuit, (power factor correction), the motor, the required control sequence, the duty cycle of the motor, drive, and load, and the pilot device, and control circuit affecting controller functions. Provide controllers that are horsepower rated to suit the motor controlled.
- D. Contacts shall open each ungrounded connection to the motor.

- E. Controller contacts shall be twin-break, silver-to-silver, renewable contacts with one set of contacts for each phase.
- F. Overload Relays: Ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of the specific motor to which connected with appropriate adjustment for duty cycle.
- G. Enclosures: For individually mounted motor controllers and control devices, comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)." Provide enclosures suitable for the environmental conditions at the controller location. Provide NEMA Type 1 enclosures except as otherwise indicated.
- H. The coverplate shall have a lock-off tab for a padlock.

2.5 FRACTIONAL HORSEPOWER MOTOR CONTROLLERS

- A. Description: Quick-make, quick-break toggle action.
- B. Single-phase motor control switches (thermal switches) for fractional horsepower motors. Single pole for 120 or 277 volt, two pole for 208 volt operation.
- C. Trip-free, toggle operated with on-off-reset position clearly indicated with neon pilot light for run indication.
- D. Thermal overload shall be ambient compensated, plug-in type element with heater rating clearly indicated. Provide one overload for single pole switch and two overloads for two pole switch.
- E. Where the motor is interlocked and controlled by another device, the motor controller shall be marked "Hand-Off-Auto Interlocked" on specified identification.

2.6 COMBINATION MAGNETIC MOTOR CONTROLLERS

- A. Description: Provide full-voltage, non-reversing, across-the-line, magnetic controller, except where another type is indicated.
- B. Control Circuit: 120 V. Provide control power transformer integral with controller where no other supply of 120 V control power to controller is indicated. Provide control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Delete items in paragraphs below not in project. Delete 1 or both of the 2 paragraphs below. Arc flash hazard analysis indicates that certain types of current limiting fuses (eg. Class j (best) and class rk1/time delay) can significantly reduce the arc flash boundary and incident energy exposure. Refer to UL 1584 and design guidelines. Combination Controller: Switch type; fused or non-fused as indicated; quick-make, quick-break switch; factory assembled with controller, and arranged to disconnect it. For fused switches, provide rejection-type fuse clips and fuses rated as indicated. Switches and fuses are specified in Division 26 Section "Protective Devices." Interlock switch with unit cover or door.
- D. Combination Controller: Motor Circuit Protector (MCP); molded-case circuit-breaker type with magnetic-only trip element calibrated to coordinate with the actual locked-rotor current of the connected motor and the controller overload relays. Provide breakers that are factory assembled with the controller, interlocked with unit cover or door, and arranged to disconnect the controller. Provide lockable disconnect device.
- E. Enhanced-Protection Overload Relay: Provide overload relays with NEMA Class 20 tripping characteristics. Select to protect motor against voltage unbalance and single phasing.
- F. Enclosure door shall be interlocked with the operating handle to prevent opening of doors with handle in the on position.

- G. Shall be provided with the following pilot lights:
 - 1. Green light to indicate motor running.
 - 2. Red light to indicate motor off.
- H. Provide Type 2 coordination (no damage protection) for motor starter per UL 508E requirements.

2.7 COMBINATION 2-SPEED MAGNETIC MOTOR CONTROLLERS

- A. General: Match controller to motor type, application, and to number of speeds. Conform to Article "Magnetic Motor Controllers" above. Provide auxiliary devices as indicated herein and on Drawings. Provide all required relays factory installed in controller enclosure.
 - B. Combination starters shall be across-the line full voltage, non-reversing type with undervoltage release for 2 speed motors. Be factory assembled and include magnetic type controllers and motor circuit protector.
 - C. The controller shall serve the purpose of starting a 2-speed motor at the pre-selected speed and to provide complete overload, overcurrent, and undervoltage protection at each speed.
 - D. The 2-speed controller shall basically be an assembly of two magnetic across-the-line controllers, one for each motor speed, mechanically and electrically interlocked and wired for automatic control through a cover mounted control switch. Include single phase protection and voltage unbalance trip relays.
 - E. Controller shall be provided with the following pilot lights:
 - 1. Green light to indicate motor high speed.
 - 2. Amber light to indicate motor low speed.
 - 3. Red light to indicate motor off.
 - F. Decelerating Relay: Provide selection of lower than current operating speed by pushbutton or pilot device as indicated with deceleration automatically timed through any intervening speeds.
- A. REDUCED-VOLTAGE MOTOR CONTROLLERS
- Auto transformer Magnetic Type: Closed transition.
 - B. Solid-State Type: Suitable for use with standard NEMA MG 1 Design B, 3-phase induction motors, providing adjustable acceleration rate control using voltage or current ramp. Provide adjustable starting torque control with up to 500 percent current limitation for 20 seconds. Provide surge suppressor in solid-state power circuits to provide 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage. Provide snubbers to prevent malfunction due to system voltage transients. Provide overload protection for NEMA Class 10 or better. Provide LEDs to indicate motor and control status including control power available, controller on, overload trip, loss of phase, and shorted SCR.
 - C. Provide automatic voltage reduction controls to reduce voltage when motor is running at light load.
 - 1. Provide a motor running contactor to operate automatically when full voltage is applied to motor. Controller shall operate as a magnetic motor controller except during starting of motor.

2.9 AUXILIARY CONTROL DEVICES

- A. General: Factory installed in controller enclosure except as otherwise indicated. Where separately mounted, provide NEMA 1 enclosure except as otherwise indicated.
 - 1. Control circuit shall be a maximum of 120 volts with individual control power transformer having Class CC dual primary and single secondary fused protection. Provide terminal lugs for connection to wiring from external remote located controls. Where indicating lights, solenoid valves and additional control components are energized from the control transformer, the control power transformer will be increased in size to handle its normal load plus the other indicated loads.
- B. Control devices such as pushbuttons and selector switches shall be heavy-duty, oil-tight, and be key operated or lockable where shown on Drawings.
- C. Control selector switches shall be as shown on Drawings and shall be one of the following:
 - 1. Start-Stop.
 - 2. Off-Auto (O-A).
 - 3. Hand-Off-Auto (H-O-A).
- D. Provide each H-O-A switch with momentary stop and start push buttons located in the "H" leg to prevent accidental starting when the switch is turned to the "H" position.
- E. Control devices shall be mounted in starter cover and be labeled with the motor or assembly which they service.
- F. Control functions shall assure proper fire alarm system overrides. If such overrides are through Division 23 or 25 hardware/software, coordinate per Division 28 Section "Fire Alarm Systems" requirements.
- G. Pilot lights shall be transformer type, heavy-duty, oil tight.
- H. Provide 1 "NO" and 1 "NC" isolated auxiliary contacts in addition to the normal hold-in contact and auxiliary contacts required for interlocks and pilot lights.
- I. Provide Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.
- J. Provide Ground Fault Relays: With sensing circuit and adjustable trip settings.

PART 3 - EXECUTION – NOT USED

END OF SECTION 262913

SECTION 263213 - ENGINE GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Coordinate generator fuel type with Project Team at start of project. Diesel, natural gas, propane, or a combination dual fuel system may be installed. Generator shall always be placed outdoor, surrounded by an enclosure for sound proofing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Caterpillar; Engine Div.
 - 2. Kohler Co.; Generator Division.
 - 3. Onan Corp./Cummins Power Generation; Industrial Business Group.
 - 4. MTU Onsite Energy Corp.
- B. Source Limitation: Obtain packaged engine generators and auxiliary components form single source and single manufacturer.

2.2 REGULATORY REQUIREMENTS

- A. IBC Chapter 17.
- B. IEEE Orange Book.
- C. ISO 8528, International Standard for Diesel and Gas Generator Sets.
- D. CEC Articles 250, 445, and 695.
- E. CEC Articles 700, 701, and 702.
- F. NEMA MG-1, Motors and Generators.
- G. NFPA 30, Flammable Liquids Code.
- H. NFPA 37, Stationary Combustion Engines and Turbines.
- I. NFPA 101, Life Safety Code.
- J. NFPA 110, Emergency and Standby Power Systems for Level [1] [2] Emergency Power Supply System.
- K. UL 2200, Standard for Stationary Engine Generator Assemblies.
- L. Engine Exhaust Emissions: Comply with applicable federal, state, and local government requirements. **[Meet EPA standards for Stationary Diesel Generator Sets for worst case project parameters at time of fabrication][.]** EPA tier level certification is required by factory testing and labeling.
- M. Noise Emission: Comply with **[applicable federal, state, and local government requirements]** for maximum noise level at **[adjacent property boundaries]** **[insert critical locations]** due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

2.3 SEISMIC PERFORMANCE

- A. Seismic Performance: Engine generator sets shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.
 3. Shake-table testing shall comply with ICC-ES AC 156. Testing shall be performed with all fluids at worst-case normal levels.
 4. Component Importance Factor: 1.5.

2.4 ENGINE GENERATOR SET (EGS)

- A. General:
1. The engine shall be 4 cycle type.
 2. The unit shall be automatic starting, engine driven, and shall have nominal electric characteristics of [277/480] [120/208] [2400/4160] [7630/13200] volts, three phase, four wire, 60 hertz, with 1800 RPM maximum speed, and shall be able to supply loads at power factors down to 80 percent, lagging.
 3. The EGS set shall be suitable for the project site environment conditions and capable of producing the maximum of any of the following sizing criteria:
 - a. [] KW emergency standby power (ESP).
 - b. Absorption of elevator systems regenerative power back into the power system per CEC 620.91(A). Coordinate with elevator manufacturer and provide power consumption analyses to determine the minimum size generator required to absorb the regenerated energy. Submit a statement from the generator manufacturer that elevator manufacturer(s) regenerative data has been reviews and included in the generator sizing criteria.
 - c. Load Steps: Across-the-line [Wye-Delta] [Auto transformer] [Solid State] [Resistive] [Reactive] starting of the largest engine generator set induction motor load (irrespective of its associated transfer switch priority) with maximum 15 percent instantaneous voltage drop after other stepped loads are successfully online based upon the following demand information:

STEPPED LOAD NO. 1 SUMMARY		
	KW	HP
Lighting:		
Receptacle:		
Miscellaneous:		
Motor:		
Heating:		

STEPPED LOAD NO. 2 SUMMARY		
	KW	HP
Lighting:		
Receptacle:		

Miscellaneous:		
Motor:		
Heating:		

STEPPED LOAD NO. 3 SUMMARY		
	KW	HP
Lighting:		
Receptacle:		
Miscellaneous:		
Motor:		
Heating:		

STEPPED LOAD NO. 4 SUMMARY		
	KW	HP
Lighting:		
Receptacle:		
Miscellaneous:		
Motor:		
Heating:		

LARGEST MOTOR LOAD	
	HP
Fire Pump:	

- d. Stepped Load No. 1 (1ATSE1 / CEC 700 Emergency Branch):
 - 1) LED Egress Lighting: [] KVA
- e. Stepped Load No. 2 (2ATSS1 / CEC 701 Standby Branch):
 - 1) Atrium Smoke Exhaust System:
 - a) See atrium smoke exhaust VFD motor loads [] scheduled on Drawing [].
 - b) Coordinate staggered or sequential motor starting with Division 23 and Division 28 fire alarm control criteria. Coordinate and describe worst case generator sizing criteria load with the atrium smoke exhaust system activated or deactivated as loads drop when the system is activated.
 - 2) Passenger VFD Elevator: [] HP
 - 3) Passenger VFD Elevator [] HP
 - 4) Freight VFD Elevator: [] HP
 - 5) Other standby loads as scheduled on "S" power code panelboard sheets (reference Drawings []).
- f. Stepped Load No. 3 (1ATSO1 / CEC 702 Optional Branch):
 - 1) 1UPS1 (IT Rooms UPS): [] KW
 - 2) 3UPS1 (Server Room UPS): [] KW

- g. Stepped Load No. 4 (1ATSO3 / CEC 702 Optional Branch):
 - 1) See loads as scheduled on Drawings [] panelboard sheets for "O" power code panelboards:
 - a) [1POH1]
 - b) [1POH2]
 - 2) Coordinate staggered or sequential motor starting with Division 23 control criteria.
 - h. Stepped Load No. 6 (1ATSO4 / CEC 702 Optional Branch):
 - 1) See loads as scheduled on Drawings [] panelboard sheets for "O" power code panelboards:
 - a) [PPOH1]
 - b) [PPOH2]
 - 2) Coordinate staggered or sequential motor starting with Division 23 control criteria.
 - i. Individually list all steps and loads used in the generator sizing calculation reports based upon the above criteria. Include manufacturer's sizing criteria and assumptions in the report outlining the generator selection.
 - j. Single Step: Pick up all of the listed loads above in a single step.
- B. Diesel Engine:
- 1. The engine shall be stationary diesel, with replaceable valve system and wet liners, with torque characteristics as needed to meet performance requirements. The engine may be turbo-charged. The engine shall be radiator cooled, suitable for full load operation at 100 degrees F outside ambient temperature. Coolant pump shall be self-sealing and pre-lubricated. Provide thermostatic temperature control.
 - 2. The engine shall meet specifications when operating on Grade DF-Z No. 2 diesel fuel. Diesel engines requiring premium fuels will not be considered. The engine shall be equipped with fuel and intake air filters; lube oil coolers, fuel transfer pump, fuel priming pump, and gear-driven water pump. To maintain environmental quality, the engine shall be equipped with a precombustion chamber fuel system or have suitable emission control equipment to ensure that gaseous exhaust emissions do not exceed manufacturer's rated speed and load as measured by SAE-J177 and SAE-J215 recommended practices. Verifications of the ability to meet these emission specifications shall be available from the engine manufacturer.
 - 3. Closed Crank Case Ventilation Filtration System: Provide a closed crank case ventilation (CCV) filtration system for the diesel engine as recommended by the engine manufacturer.
 - a. Include CCV system components, piping, and auxiliary equipment as listed below:
 - 1) Pressure regulator.
 - 2) Impactor-separator.
 - 3) Bypass and port.
 - 4) Breather elements and filters.
 - 4. Fuel shall be supplied by a gear drive fuel pump to individual fuel injectors or nozzles for each cylinder. Piping shall be arranged to provide circulating fuel flow with excess returning to the main fuel tank. Piping shall be self-purging of entrained air. Provide flexible fuel connections as required. Piping shall be Schedule K hard copper with cast, solder type fittings. Check valve shall be ball type steel.

C. Natural Gas Engine:

1. The engine shall be stationary spark ignited natural gas type, with replaceable valve system and wet liners, with torque characteristics as needed to meet performance requirements. The engine may be turbo-charged. The engine shall be radiator cooled, suitable for full load operation at 100 degrees F outside ambient temperature. Coolant pump shall be self-sealing and pre-lubricated. Provide thermostatic temperature control.
2. The engine shall be equipped with fuel and intake air filters; lube oil coolers, and gear-driven water pump.
3. The engine shall be carbonated with a low pressure fuel utilization system. The air intake system shall be balanced for even fuel distribution. A reserve flow design shall provide adequate fueling during load pick-up.
4. The engine shall have a breakerless, low tension ignition system with fully sealed, module type electronics. Ignition must fire each cylinder independently, with timing built into an integral unit. High voltage spark plug cables shall be RFI suppressant type. Spark plug probes shall be Teflon insulated, impervious to oil, antifreeze, and water.

D. Specific functions and features required for the engine-generating set are as follows:

1. Provide electric resistant type coolant heater of sufficient capacity to maintain a 90 degrees F coolant temperature in a 40 degrees F ambient, thermostatically controlled. Heater shall be for [480] [277] [120] [208] volt operation. Optional heater voltage acceptable with Division 26 coordination responsibility.
2. The engine shall have full pressure lubrication by gear type oil pump to all crank shaft connecting rod, camshaft, and gear train bearings. Provide full flow replaceable oil filter, safety pressure relief, and oil cooler. A lube oil drain shall be extended beyond the skid base. Provide required lubricating oil as recommended by unit manufacturer for installation location.
3. Engine and generator shall be "factory package" mounted on a rigid steel skid base.
4. The EGS shall be supplied with a unit mounted control panel housing all gauges, meters, etc., necessary for the complete and proper inspection, surveillance during operation, care, maintenance and manual operation, and stopping of the engine. The panel shall be mounted on vibration isolators.
5. For engine-generator sets rated above 200 KW, speed control shall be by electronic isochronous governor, maintaining +/-1 percent frequency from no load to full load, and permitting no more than 10 percent frequency drop on single step application of full rated load. Provide mechanical manual speed and adjustment for trimming set speed. The generator set shall be suitable for parallel operation.
6. Engine shall be complete with all integrally mounted controls necessary to transmit pre-shutdown audible and remote alarm signal and to shut down the engine in the event that hazardous or damaging conditions occur while the engine is running, such as low lubricating oil pressure, high water temperature, and over-speed. Provide terminals for future extension of signal circuiting for each condition to remote devices. Include terminals for remote indication of "failure to start" condition.

2.5 ENGINE GENERATOR SET ACCESSORIES

A. Engine Starting System:

1. Engine shall be complete with an integrally mounted DC electric cranking motor and other equipment and appurtenances as required for self-contained automatic electric starting in response to the closing of a contact in a two-wire control circuit extension from the generator set cranking circuit.

2. Automatic electric starting equipment shall include a cranking feature of three (3) cycles each consisting of 15 seconds cranking duration and 15 seconds reset duration to provide additional "startup" attempts following a first "startup" failure. Cranking capacity shall be rated in a 0 degree F ambient, using the standard jacket water heater. The equipment shall also include a lock-out feature which shall stop all "start-up" attempts following three (3) unsuccessful attempts and shall initiate a "lock-out alarm" signal (audible and visible).
3. Provide all necessary interconnecting power and control cables to battery and charging system.
4. Batteries shall be lead calcium type of voltage and rating required for engine starting and control power, industrial grade, pocket plate type specifically designed and sized for continuous charging and engine starting service with five (5) years life.
5. Battery rack shall be PVC coated after fabrication steel construction of size and arrangement to accommodate all required batteries. Equip rack with legs to maintain 6 inches minimum clearance from the floor.
6. Battery charger shall be current limiting and fully automatic, self-regulating, solid-state full wave rectifier type of unit construction and capable of recharging the starting batteries in five (5) hours after a maximum crank cycle.
 - a. Maintain batteries of 2.17 volts per cell. Equip charger with all normal components including DC ammeter and DC voltmeter; malfunction detector with controls for remote annunciator, sensing loss of charger output current, excess charger current and output undervoltage. Bypass alarm during engine starting cycle.
7. Provide all necessary interconnecting power and control cables to battery. Heaters and temperature maintenance system.
8. Provide battery pad heaters with thermostat control.
9. Accessories:
 - a. Battery intercell, interunit, intertier, end-to-line interrack and back-to-back interrack connections of lead coated copper.
 - b. Battery anti-corrosion compound.
 - c. Battery connector nuts and bolts.
 - d. One portable hydrometer.
 - e. One thermometer with a 2 degree F scale and +/- 1 degree F accuracy suitable for wall mounting.
 - f. One battery lifting device (exclude if batteries have integral handles).
 - g. One set of battery and cell numbers.

B. Generator:

1. The generator shall be a three phase, 60 hertz single bearing, synchronous type with brushless excitor and be built to NEMA standards. Class H insulation shall be used on the stator and rotor, and both shall be further protected with 100 percent epoxy impregnation and an over-coat of resilient insulating material to reduce possible fungus and/or abrasion deterioration. Generator shall be fully self-ventilated with drip-proof construction and shall be suitable for parallel operation. Maximum temperature rise measured by resistance method at 40 degrees C ambient shall not exceed 105 degrees C.
2. Exciter and volts per hertz electronic voltage regulator shall be capable of maintaining stability within 0.5 percent at constant speed. Voltage regulation shall not exceed +/- 0.5 percent from no-load to full load. Maximum voltage drop shall be 15 percent on each step application to 100 percent resistance type load. Unit to recover to within 0.5 percent rated frequency and voltage within 5 seconds. Include the regulation effects of the engine governor in the stated generator performance figures. Readily accessible voltage drop, voltage level, and voltage gain controls shall be provided. Voltage level adjustment shall be a minimum of +/- 5 percent. The solid state regulator module shall be shock mounted and epoxy encapsulated for protection against vibration and atmospheric deterioration.

3. The excitation system shall be self-protecting. The manufacturer shall submit a test report on a prototype generator verifying that a bolted fault on the generator terminals will not cause failure of the excitation system. Generator shall have built-in statically-regulated, statically-excited system with amortisseur windings.
4. The generator shall have an ample size terminal box to receive the conduits and cables indicated and meet applicable UL requirements for wire bending and working space. All generator leads shall be brought out. The appropriate leads shall be connected to the neutral terminal[**and not grounded to the frame**].

C. Control Panel:

1. The EGS shall be provided with a microprocessor-based control system which is designed to provide automatic starting, monitoring, and control functions for the EGS system. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this Specification. The control shall be EGS mounted and shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered. The control shall be UL 508 labeled, CSA282-M1989 certified, and meet IEC8528, Part 4. All switches, lamps, and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std. 461C, Part 9, and IEC Std. 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE 587 for voltage surge resistance. The control panel shall include the following features and functions:
 - a. Three position manual control switch labeled RUN/OFF/AUTO:
 - 1) In the RUN position, the EGS shall automatically start, and accelerate to rated speed and voltage. In the OFF position, the EGS shall immediately stop, bypassing all time delays. In the AUTO position, the EGS shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 - b. Red "Mushroom Head" Push-Button EMERGENCY STOP Switch:
 - 1) Depressing the emergency stop switch shall cause the EGS set to immediately shut down and be locked out from automatic restarting.
 - c. Push-Button RESET Switch:
 - 1) The RESET switch shall be used to clear a fault and allow restarting the EGS after it has shut down for any fault condition.
 - d. Push-Button PANEL LAMP Test Switch:
 - 1) Panel lamp switch shall cause the entire panel to be lighted with DC control power.
2. General Set AC Output Metering: The EGS shall be provided with a metering set with the following features and functions:
 - a. Voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. These meters shall be provided with a phase select switch.
 - b. Digital metering set, 0.5 percent accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages and shall display all three phase voltages (line to neutral or line to line) simultaneously.

3. Engine Generator Set Alarm and Status Message Display:
 - a. The EGS shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The EGS control shall indicate the existence of the alarm and shutdown conditions on a digital display panel for Level 1 generating systems as outlined in NFPA 110, plus other indicators as specified herein.
4. Control Functions:
 - a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
 - b. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this Specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
 - c. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender of wiring components, and an actual failure condition.
5. Alternator Control Functions:
 - a. The EGS shall include an automatic voltage regulation system which is matched and prototype tested with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control build-up of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of (58-59) Hz. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alpha-numeric LED readout to indicate setting level.
 - b. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.
 - c. Controls shall be provided to monitor the output current of the EGS and initiate an alarm when load current exceeds 100 percent of the rated current of the EGS on any phase for more than 60 seconds. The controls shall shut down and lock out the EGS when output current level approaches the thermal damage point of the alternator, except when serving a fire pump where only an overspeed condition may cause engine shut down.
 - d. Controls shall be provided to monitor the KW load on the EGS and initiate an emergency load shed alarm condition when total load of the EGS exceeds the EGS rating for in excess of 5 seconds.

- e. Emergency load shed control shall be activated by the emergency generator control panel when 100 percent of the standby rating is reached for [3] [5] [7] seconds. The load shed mode shall cause the lowest priority automatic transfer switch to transfer away from the emergency load position and shed the associated load until operator manual load addition. This load shed shall be by direct wiring from the emergency generator control panel (set of dry contacts) to the designated load shed automatic transfer switch. Loads as indicated in CEC 695, 700, and 701 shall not be included in the above mode of operation.
 - f. An AC over/under voltage monitoring system which responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110 percent of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130 percent. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85 percent for more than 10 seconds.
 - g. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25 VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds, a "weak battery" alarm shall be initiated.
 - h. When required by California Electrical Code or indicated on Drawings, the control system includes a ground fault monitoring relay. The relay shall be adjustable from 100-1200 amps and include adjustable time delay of 0-1.0 seconds. The relay shall be for indication only and not trip or shut down the EGS. Note grounding requirements for the EGS and provide relay which will function correctly in system as installed.
6. Control Interfaces for Remote Monitoring: All control and interconnection points from the EGS to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:
- a. Two sets of form "C" dry common alarm contact set rated 2A @ 30 VDC to indicate existence of any alarm or shutdown condition on the EGS.
 - b. One set of contacts rated 2A @ 30 VDC to indicate EGS is ready to load. The contacts shall operate when voltage and frequency are greater than 90 percent of rated condition.
 - c. A fused 10 amp switched 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this current whenever the EGS is running.
 - d. A fused 20 amp 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
 - e. The control shall be provided with provisions for connection of remote monitoring equipment as described herein or shown on the Drawings.
7. Generator Protection:
- a. Provide the main feeder fed from the generator with a main service rated fully adjustable solid-state circuit breaker mounted **[adjacent to the generator assembly]** sized at no more than 125 percent of the generator nameplate full load amperage rating per Drawings and Division 26 Section **["Protective Devices."]** **["Medium Voltage Switchgear."]** **[Provide same breaker manufacturer as Division 26 Section "Panelboards" for project continuity.]**
 - b. If inherent generator alternator protection matched to alternator damage curve, provide remote disconnect **[molded case]** **[medium voltage interrupter switch]** switch device adjacent to the generator assembly.

8. Include contacts for remote breakglass station manual shutdown. Refer to Division 26 Section "Wiring Devices" for breakglass station specifications.

D. Day Tank:

1. The day tank shall be manufactured from ungalvanized steel and have **[150]** gallon capacity.
2. The day tank shall have fuel level gauge, overflow piping to main tank, surge baffles, vent, valved drain, and engine supply line check valve. **[Division 21 will supply remote dual] [Provide]** electric motor driven fuel transfer pumps each of lift and capacity to deliver fuel to the day tank faster than the engine can consume at peak load. Provide float-operated level switch and contacts for pump control. Provide two (2) parallel float operated switches for remote indication of high and low fuel levels. **[Provide motor with both overload and branch circuit protection per CEC Code.]** Provide rupture containment retention tank with alarm float switch having two alarm contacts. Also provide a rotary hand pump of minimum 5 gpm capacity and necessary valving to tank. Tank, head pump, and accessories shall be UL listed packaged unit as manufactured by the Simplex Company, Inc. (similar to Model SFT 150A) or Tramont.
3. Provide Firematic valve on fuel line to generator equal to "Preferred Utilities Fusomatic Valve."
4. Provide solenoid valve on fuel line to generator and connect to breakglass station control circuit for fuel shutoff.
5. The control connection between the day tank fill switch and the fuel transfer pumps must be hard wired by Division 26.
6. Provide alarm contacts for remote annunciate and Division 23 BAS monitoring.

E. Skid Base Fuel Tank:

1. The fuel tank shall be of the EGS subbase double wall construction type and shall be manufactured from ungalvanized steel and have sufficient usable capacity for 2 hours for building and 8 hours for server room, supply **[]** gallons of full load operations without being refilled. The tank shall be structurally supported such that the bottom of the filled tank is 1/2 inch above the pad (to allow for inspection).
2. The tank shall have fuel level gauge, vent, valved drain, and engine supply line check valve. Provide two (2) paralleled float operated switches each for remote indication of high and low fuel levels, and retention tank alarm. Provide an inspection port (capped pipe) for retention tank. Also provide a rotary hand pump of sufficient capacity, about 5 gpm, and necessary valving to tank to pump into tank from hand carried tank. Tank, hand pump, and accessories shall be packaged unit as manufactured by the Simplex Company, Inc. or equal as recommended by the generator set manufacturer.

F. Cooling System:

1. Cooling shall be by heavy duty machine mounted radiator, belt driven special high pressure centrifugal fan, integral circulating pump, and flow modulating thermostatic valve. Pressure rating shall be as recommended by manufacturer for use with sound attenuators used for intake and exhaust air plenums. Drive fan and pump directly from the engine crankshaft. Size the fan for rated air flow through the radiator with 5/8 inch external static pressure in the air circuit. Equip the radiator with flange for duct connection, and with suitable fan guard. Use 50-50 mixture of ethylene-glycol and water to prevent freezing.
 - a. The cooling system shall be rated for full rated load operation in 122 degrees F ambient conditions, measured maximum 5 feet above generator centerline.

2. Cooling shall be by a remotely mounted radiator located as shown on Drawings. The radiator shall be of the **[horizontal]** **[vertical]** fan type with vertical air discharge consisting of steel frame, cooling coils, legs, fan, fan guard, core guard, and fan motor, and shall meet the following criteria:
- a. Sufficient capacity to remove the heat rejected to the cooling system by the diesel engine as recommended by the engine manufacturer in an ambient temperature of 100 degrees F, 1500 feet above sea level using a 50 percent ethylene glycol antifreeze solution.
 - b. Designed to withstand winds up to 50 mph velocity and shall have means for bolting to a floor or support.
 - c. Water cooling coils having brass tubes and copper fins with the fins soldered to the tubes. Water tubes shall be soldered into brass header plates. Drain and vent connections shall be provided. End tanks shall be of steel.
 - d. Not less than four blades of aluminum or steel and driven by an electric motor, either directly connected to the fan or connected by a belt driven system. The tip speed shall not exceed 8000 feet per minute.
 - e. Fan guard of 1/8 inch or heavier round galvanized steel wire.
 - f. Fan motor totally enclosed, fan cooled, suitable for outdoor use at 480 volts, 3 phase, 60 Hz. The horsepower of the motor shall be sufficient to drive the fan without overheating or damage. A fused disconnect switch of the proper size, designed for use outdoors, shall be installed near the radiator to provide a service disconnect. A motor starter of the proper size shall be supplied inside the generator control panel and wired to automatically turn the fan motor on whenever the engine is running even if the generator output circuit breaker is open.
 - g. Deration system furnished as recommended by the engine manufacturer to continuously bleed trapped air bubbles out of the engine. Be the responsible for the coordination of the installation of the deration lines. Any required purge tanks, expansion tanks, manifolds, etc. shall be furnished by the Contractor.
 - h. Remote mounted expansion tank of the proper size furnished as recommended by the generator set supplier. The tank shall include a filler neck, pressure cap, and sight gauge. The expansion tank shall be located so that it is at the highest point in the cooling system.
 - i. Stainless steel flexible connections provided at the engine and radiator ends of the piping as recommended by the supplier. The engine exhaust manifolds, turbochargers, and connecting piping shall be water cooled or protected by a removable and reusable insulating blanket material such as that manufactured by Hitco, Inc. While the engine is operating at full load the surface temperature of the blanket shall remain cool to the touch.
 - j. A hot well tank **[or heat exchanger system at Division 26 option]** shall be provided between the engine and the remote radiator. The tank shall be as recommended by the engine manufacturer but not be any smaller than as provided by the following formula:

$$C = (R + P + 1/4W + 1/4E) \times 1.05$$

where:

C = Capacity of Hotwell (gallons)

R = Capacity of Radiator (gallons)

P = Capacity of Piping (gallons)

W = Flow rate of auxiliary water pump (GPM)

E = Flow rate of engine water pump (GPM)

- 1) The connection to the hot well shall be directed to permit separation of entrained air and minimize turbulence. Maximum blending between the remote radiator system and the engine is required. A baffle between the hot side and cold side of the hot well shall be provided with passage holes equal to the area of the radiator connections. The remote radiator piping diameter shall be doubled approximately 4 feet before entering the hot well to reduce turbulence and aeration problems. The hot well shall be vented to the atmosphere and include a sight gauge and make up line. The hot well shall be installed near the engine raised off the floor so that the level of the coolant in the hot well is above the highest point in the engine cooling system when the engine is running. A vent and deration line shall be fitted from the engine to the hot well per the manufacturer's instructions.
- 2) An auxiliary motor driven pump shall be provided to circulate the coolant between the hot well and the remote radiator. The pump shall be sized to match the engine's water pump flow rate against the head and frictional losses in the system.
- 3) Additional water conditioning equipment shall be furnished to treat the large amount of coolant as required by the manufacturer of the engine.

G. Exhaust System:

1. Silencer shall be critical type. Supply 1 or 2 silencers as required per engine. Provide Y-joint as needed. Silencer shall be of size recommended by the EGS manufacturer to, along with the remainder of exhaust system, remain below maximum back pressure criteria, Maximum Type M-51, Burgess Manning Type BEO, Nelson, or approved equal.
2. Provide flexible tubing between engine and silencer, seamless, stainless, UL listed, gas-tight, with bolted or screwed flange fittings. Provide lock washers for all bolts and nuts.
3. Provide rain cap and bird screen on and off exhaust pipe.
4. The maximum allowable exhaust back pressure shall be 40 inches H2O. Be responsible to coordinate the entire installation to ensure this requirement.

H. Alarm Annunciator:

1. Provide an alarm annunciator for remote installation, flush or surface mounted as shown on Drawings (near electrical panel feeding generator).
2. Annunciator shall be lamp or LED type with an individual backlighted, labeled lens for each alarm point and common audible alarm signal. Lock-in individual point on momentary alarm signal. Provide switch for silencing the audible device. Turn off the alarmed point indicator on "Return to Normal" without either audible or visual signal. Provide the number of points required plus two spare points. Provide power for annunciator operation from associated generator starting battery (from paralleling system best battery selector system). One annunciator backbox shall be provided with single face for all alarm points. Provide a "lamp test" button for checking incandescent lamp or LED filaments.

I. Alarm Annunciation:

1. The control and monitoring system for the building complex shall provide the necessary alarm and annunciating functions for the EGS system. System shall email/text alert to BMS.
2. Necessary sensors with contacts to be connected to the control monitoring indicating and alarm points shall include:
 - a. Control Switch Not In Auto.
 - b. Generator Power On.
 - c. Overcrank Shut-Down.
 - d. Overspeed Shut-Down.
 - e. High Coolant Temperature, Pre-Alarm.
 - f. High Coolant Temperature, Shut-Down.
 - g. Low Lube Oil Pressure, Pre-Alarm.

- h. Low Lube Oil Pressure, Shut-Down.
- i. Low Fuel, Day Tank.
- j. Low Fuel, Main Tank.
- k. High Battery Voltage.
- l. Low Cranking Voltage.
- m. AC Power Failure to Charger.
- n. Ground Fault.

J. Alarm Contact Terminals:

- 1. Provide alarm and safety indicators, sensing devices and/or contacts, wiring in conduit, and associated contact terminals for annunciation of EGS and accessory alarms for extension by Division 21 to the Automatic Temperature Control (ATC) system.
 - a. Generator "RUN," "ALARM" (grouped), "TROUBLE," and "PEAK SHAVE MODE." Indications shall be provided.

K. Outdoor Engine Generator Enclosure:

- 1. Non Walk-In EGS Manufacturer's Enclosure: UL 2200 listed, skid base, vandal resistant, sound attenuating, weatherproof steel housing erected on concrete foundation. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- 2. Sound Attenuation Level: **[II: 63 to 78 dBA at 23 feet (7 meters)] [III: 68 to 70 dBA at 23 feet (7 meters)]**.
- 3. Enclosure: Rated NEMA 4 and IEC 60529 Ingress Protection Class 66 with pitched roof. Prime paint with two coats of factory primer and two coats of finish paint; color as directed by Architect.
- 4. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads of up to 150 mph (241 km/h).
- 5. Seismic Design: Comply with seismic requirements in Division 26 Section "Vibration and Seismic Controls."
- 6. Piano Hinged Doors: With stainless steel lockable latches. Bond enclosure doors to EGS. Provide four (4) sets of keys to Owner's representative. Submit receipt to Architect.
- 7. Emergency Shutdown Stations: Within each side of enclosure.
- 8. Space Heater: Thermostatically controlled and sized to prevent condensation.
- 9. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.
- 10. Muffler Location: Within enclosure.
- 11. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
 - a. Louvers: Fixed engine, cooling air inlet and discharge. Storm proof and drainable louvers prevent entry of rain and snow.
 - b. Automatic Dampers: At engine cooling air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
 - c. Ventilation: Provide temperature controlled exhaust fan interlocked to prevent operation when engine is running.
- 12. Wiring Devices: Per Division 26 Section "Wiring Devices."
- 13. Convenience Outlets: Factory wired GFCI. Arrange for external electrical connection.
- 14. Floor design shall include a removable panel below the engine oil pan.

15. Manufacturers: Pritchard Brown, Chillicothe Metal Co. (CMCO), Tramont Corp., Sauk Technologies, and Silex.

L. Vibration Isolation:

1. Provide per Division 26 Section "Vibration and Seismic Controls."

M. Load Bank:

1. Description: Weatherproof, radiator mounted, forced air cooled, resistive load bank unit providing a balanced 3-phase, delta connected load to EGS at 100 percent rated system capacity, at 80 percent power factor, lagging. Unit shall be composed of separate resistive load banks controlled by a common control panel mounted to the side of the load bank. Unit shall provide selective control of load in 25 percent steps with minimum step changes of approximately 5 to 10 percent available.
2. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.
3. Load Bank Heat Dissipation: The engine radiator will provide air to cool the load bank. Coordinate ratings with EGS manufacturer and submit with shop drawings. The load bank shall have a static pressure drop of approximately 0.1 inch H₂O at design velocity (850/ft/min).
4. Load Element Switching: Remote controlled contactors shall switch groups of load elements. Contractor coils shall be rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within the load bank enclosure, accessible from exterior through hinged doors with tumbler locks.
5. Load Bank Enclosures: The load bank enclosure shall be NEMA Type 3R. The load bank shall be a completely self-contained unit for mounting in the radiator air stream. The load bank shall include all resistive load elements, load control contactors, and protective devices. The load bank shall have a core size compatible with EGS and radiator flanges and shall have a self-contained 2-1/2 inch flange on the top and bottom edges on both the front and back for factory mounting.
6. Protective Devices: Power input circuits to load banks shall be fused, selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks shall be provided on access panels and doors disconnect load power, control, and heater circuits. Short-circuit devices shall be noninterchangeable fuses with 200,000A interrupting capacity.
7. Control Panel: The control panel shall be mounted on the side of the load bank in a NEMA 250, Type 1 enclosure and shall include a control power switch and pilot light, and switches controlling groups of load elements.
8. Control Sequence: Control panel shall be preset for adjustable single-step loading of generator during automatic exercising.
9. Field Wiring: Provide terminal block, at contactors for single point 3-phase connection.
10. Manufacturers:
 - a. Avtron Manufacturing, Inc.
 - b. Fermont Div., Dynamics Corporation of America.
 - c. Libby Corporation.
 - d. Simplex.

PART 3 - EXECUTION – NOT USED

END OF SECTION 263213

ENGINE GENERATOR SETS

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SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Transfer switch manufacturer must be approved to interface with manufacturers of generator.
- B. Transfer Switch Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ASCO Power Technologies, LP; a Division of Schneider.
 - 2. Russelectric, Inc.
 - 3. Caterpillar; Generator Division with Zenith, a Division of General Electric, CTE Series contactor only.
 - 4. Kohler Co.; Generator Division with ASCO contactor only.
 - 5. MTU Onsite Energy Corp. with ASCO contactor only.
 - 6. Onan Corp./Cummins Power Generation; Industrial Business Group.
- C. The emergency generator control system, associated batteries and battery chargers, and automatic transfer switches shall be supplied by the engine generator set manufacturer for unit responsibility.
- D. Submit proof from the manufacturers of the engine generator set and transfer switches of qualified service capability, acceptable to the Engineer, in the area where the system will be installed.

2.2 REGULATORY REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with:
 - 1. NEMA ICS1, Industrial Control and Systems: General Requirements.
 - 2. IEEE Orange Book.
 - 3. CEC Articles 250, 445, and 695.
 - 4. CEC Articles 700, 701, and 702.
 - 5. NFPA 101, Life Safety Code.
 - 6. NFPA 110, Emergency and Standby Power Systems for Level 2 emergency power supply system.
 - 7. UL 1008, Standard for Automatic Transfer Switches.

2.3 AUTOMATIC TRANSFER SWITCHES (ATS)

- A. General:
 - 1. Automatic transfer switches shall consist of a power transfer module and a control module, interconnected to provide complete automatic operation. Automatic transfer switches shall be mechanically held and electrically operated by a single electrical operator energized from the source to which the load is to be transferred. The switch shall be rated for continuous duty and be inherently double throw. The switch shall be mechanically interlocked to ensure only one of two possible positions - normal or emergency, except for switches serving motor loads which are addressed in this Section.

2. The automatic transfer switches shall be rated to withstand the RMS symmetrical short circuit and 3 cycle withstand and closing ratings (WCR) current generally available at the automatic transfer switch terminals with the type of overcurrent protection as scheduled and in conjunction with the approved coordination study.

B. Operation:

1. Each automatic transfer switch shall sense partial or complete loss (less than 85 percent) of normal voltage in any phase. After a time delay of 2 seconds (adjustable 0.0 to 6 seconds) a starting signal shall be transmitted over a 2-wire circuit to the EGS starting controls.
2. All phases of the normal sources shall be monitored line-to-line. Close differential voltage sensing shall be provided on all phases. The pick-up voltage shall be adjustable from 85 percent to 100 percent of nominal and the dropout voltage shall be adjustable from 75 percent to 98 percent of the pick-up value. The transfer to emergency will be initiated upon reduction of normal source to 85 percent of nominal voltage and retransfer to normal shall occur when normal source restores to 95 percent of nominal on all phases.
3. All phases of the emergency source shall be monitored for voltage and frequency for return to normal if the emergency source becomes unstable. The pick-up voltage shall be adjustable from 85 percent to 100 percent of nominal and set at 90 percent. The pick-up frequency shall be adjustable from 90 percent to 100 percent and set at 57 hertz.
4. For priority 1 loads as scheduled on Drawings, transfer time delay shall be set to zero seconds.
5. For subsequent priority (delayed) loads as scheduled on Drawings, each subsequent priority transfer switch transfer time delay shall be set to increments of 4 to 5 seconds above previous priority transfer switch.
6. When normal power returns, each transfer switch shall, after a time delay, retransfer to "normal" side. The time delay shall be adjustable from 0-30 minutes and set at 30 minutes. If during this period, the generator voltage should fail, each transfer switch shall immediately return to "normal."
7. Generator cool-down shall be provided by a time delay relay providing for unloaded running of the generator for a period of 0 to 10 minutes.
8. Motor load transfer switches shall be factory equipped with the programmed transition feature. This feature shall provide a field adjustable time delay during which time the load is isolated from both power sources, to allow residual voltage of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. The programmed transition feature shall have an adjustable time of 0 to 7.5 seconds. All transfer switches without programmed transition feature shall be capable of addition of the programmed transition feature in the field without transfer switch replacement. Transfer methods that use the phase relationships between the two power sources to control a transfer initiation time are also acceptable in both directions.

C. Materials:

1. Each automatic transfer switch shall be rated for continuous duty when enclosed in a (non-ventilated distribution switchboard or) surface, wall-mounted in NEMA 1 enclosure. It shall be rated for all classes of loads, including inductive and non-inductive at 480 volts, and tungsten lamp at 250 volts. The switch portion shall be designed, built, and tested to close on an in-rush current up to an including 20 times the continuous rating of the switch and rated to close on and withstand a fault current as indicated without welding or excessive burning of contacts.
2. Transfer switches shall meet all provisions of the latest version UL1008.
3. All main contacts shall be silver composition, wiping action type. Switches rated 600 amperes and above shall have separately removable arcing contacts. The operating transfer time in either direction shall not exceed one-sixth (1/6) of a second.

4. All control module relays, timers, control wiring, and accessories shall be front accessible. Inspection of all contacts (movable and stationary) shall be possible from the front of the enclosure without disconnection of drive linkages or power conductors. All control wires shall be terminated with tubular sleeve type markers or be permanently marked on both ends. Adjustable time delays shall have calibrated dials or dip switches for precise settings. Transfer switches utilizing controls which require additional test equipment for precise time delay, voltage and/or frequency settings shall include all necessary test equipment, arranged for mounting with the transfer switches. Control modules shall be:
 - a. Manufacturer's front accessible LCD/keypad programmable microprocessor-based **[dip-switch adjustable microprocessor-based] [standard] [hardwired with relays, etc.]** design meeting requirements herein.
 - b. Coordinated to match existing automatic transfer switch control units.
 - c. Hardwired through each automatic transfer switch for external control connections. Software based interconnection to common monitor/control contacts are not acceptable.
5. Automatic transfer switches utilizing components of molded-case or insulated-case circuit breakers are not acceptable. Automatic transfer switches utilizing contactors, or part thereof which have not been intended for continuous duty or repetitive load transfer switching are not acceptable.
6. Transfer switches containing neutral conductors shall be provided with a fourth pole for neutral switching as scheduled on Drawings. The fourth pole must have the same short circuit and withstand ratings as the main poles.
7. The short circuit, withstand and close in capability shall meet or exceed the ratings scheduled on Drawings for all poles of a three or four pole switch when operating at rated voltage.
8. Each Transfer Switch shall have:
 - a. An enclosure with internal copper ground bar with lugs for incoming ground wires.
 - b. Provisions for electrically disconnecting the control section from the transfer section to permit safe access for maintenance or service during periods of normal operation.
 - c. Front Panel Devices: Provide devices mounted on front of main cabinet door consisting of switch position indicator lamps: normal (white), emergency (red), normal source available (green), emergency source available (red), and toggle switches to provide the following positions and functions:
 - 1) Test: Simulated normal power loss to control unit for testing of generator set, including transfer of load. Controls shall include provisions to automatically return the system to the normal power source if the generator set fails during any test or exercise period.
 - 2) Normal: This is a normal operating position and it restores the load to the normal source after test and after time delays.
 - 3) Retransfer: Momentary position to over-ride retransfer time delay and cause immediate return to normal source after test or actual outage. (This feature may be push-button activated).
 - d. Terminal blocks with identification of all external connections, cross-referenced to the schematic wiring diagram.
 - e. A laminated engraved nameplate on the front of the enclosure, carrying its designation.

- f. For other than bypass/isolation type transfer switches, a UL listed manual operator shall be provided in accordance with UL1008, arranged so that the transfer switch can be manually operated under load by opening the enclosure door for access to the operator handle. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly.

D. Accessories:

1. Exercise timer to start generator set and transfer load on transfer switch having closest proximity to associated generator set. Set timer to run generator for 25 minutes under load and 5 minutes unloaded. Timer shall operate on a **[one-week] [two-week]** cycle.
2. Start contacts for the engine control shall be gold type, dry contacts wired to easy access terminal block and compatible with the generator set control equipment furnished.
3. Two normally opened and two normally closed auxiliary contacts rated 10 amps, 250 volts, 60 hertz, AC (for remote monitoring of the switch position).
4. Elevator contacts shall be provided to send a preliminary (5 second) signal to the elevator controllers prior to transfer in both directions (for utility available and generator running). The contact shall be closed only during this 20 second period.
5. Operation Counter.
6. Provide other accessories as scheduled on Drawings.
7. Rubber Mats:
 - a. Provide corrugated, non-conductive, rubber mats per Division 26 Section "Hangers and Supports."
 - 1) In operating and maintenance aisles on all sides of each electrical assembly.
 - 2) As shown on Drawings or otherwise extending the longer of the electrical assembly or associated housekeeping pad and 4 foot minimum width.

E. Isolation/By-Pass Capability:

1. Automatic transfer switches in this facility shall be the isolation/bypass (IBTS) type as shown on Drawings. The IBTS configuration will allow either the normal or the emergency source to be connected directly to the load to allow the normal automatic transfer switch to be isolated and deenergized for maintenance, testing, or repair. Permanently mounted external operating handles shall be used. Positive mechanical interlocks shall prevent source to source interconnections. Bypass contacts shall be make-before-break or break-before-make, quick-make, quick-break with the operating mechanism, load-break capability and electrical ratings identical to the main automatic transfer switch. The automatic transfer switch shall be full drawout construction with no need for any electrical or mechanical disconnections. The IBTS configuration shall operate as a manual transfer switch when the ATS is removed. The IBTS switch shall be fully mechanical and not dependent upon relays, interlocked circuits, separate contactor or operator dependent timing for safe operation. Other features:
 - a. All bus interconnections shall be silver plated.
 - b. All operating handles shall be permanently attached.
 - c. Provide two sets of auxiliary contacts, each for remote monitoring of switch placed in normal bypass and emergency bypass modes for associated front cover pilot lights and remote monitoring. Provide associated pilot lights for each mode of operation. One set of contacts shall be for future customer use.

F. Closed-Transition Switching Capability:

1. The chiller transfer switch shall be of the closed-transition transfer switch (CTTS) type to transfer the chiller load in a make-before-break action between the utility and standby generating system sources. Both sources shall be connected to the load, in phase, for a maximum period of 100 milliseconds through the use of an in-phase monitor. This operation shall not alter the speed or require active control of the emergency generator sets. The transfer shall occur only when the two sources are within +/- 5 electrical degrees maximum and +/- 5 percent maximum voltage differences to limit generator synchronizing currents.
2. The switch operation shall be:
 - a. Automatic in the peak shave mode of operation.
 - b. Negated otherwise.
3. A fail-safe feature to force the second available source open and signal an alarm condition shall be made in the event closed transition (opening of the original source) does not occur within the 100 millisecond time limitation. Operation of this feature shall require manual reset.
 - a. If both operators should fail simultaneously while their contacts are both closed, a dry contact shall close to shunt trip remote source protective devices.
4. Local Electrical Utility company approval of the specific CTTS for this project must be accompanied with Shop Drawing submission prior to acceptance.
 - a.

G. Tests:

1. Certified independent laboratory test data on a switch of the same design and rating shall be provided to confirm the following switching abilities:
 - a. Overload and endurance per Tables 21.2 and 23.2 of UL1008 when enclosed according to Paragraph 1.6.
 - b. Temperature rise tests after the overload and endurance tests to confirm the ability of the transfer switches to carry their rated current within the allowable temperature limits of the insulation in contact with current-carrying parts.
 - c. No welding of contacts. Transfer switch must be operable by the normal means after the withstand current tests.
 - d. Dielectric tests at 1960 volts, RMS, minimum after the withstand current test, per UL1008.
2. All transfer switches shall be subjected to the following factory tests:
 - a. The complete automatic transfer switch shall be tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
 - b. The complete automatic transfer switch shall be subjected to a dielectric strength test per NEMA Standard ICS 1-109-05.
 - c. The control panel shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472-1974 (ANSI C37.90a-1974) and the impulse withstand voltage test in accordance with NEMA Standard ICS-1-109.

2.4 TRANSFER SWITCH REMOTE ANNUNCIATOR SYSTEM

- A. Source Limitations: Same manufacturer as transfer switches.
- B. Location: Place in main electrical room near panel feeding normal side of ATS(s).

TRANSFER SWITCHES

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- C. Functional Description: Remote annunciator panel shall indicate functional conditions for transfer switches. Annunciation includes the following:
 - 1. Sources available, as defined by actual pickup and dropout settings of transfer switch controls.
 - 2. Switch position.
 - 3. Switch in test mode.
 - 4. Failure of communications link.
- D. Annunciator Panel: LED lamp type with audible signal and silencing switch.
 - 1. Indicating Lights: Grouped for each transfer switch monitored.
 - 2. Label each group indicating transfer switch it monitors, location of switch and identity of load it serves.
 - 3. Mounting: Flush, modular, steel cabinet.
 - 4. Lamp Test: Lamp test switch on panel front.
 - 5. Power Service: Generator sets best battery.

2.5 TRANSFER SWITCH REMOTE ANNUNCIATOR AND CONTROL SYSTEM

- A. Source Limitations: Same manufacturer as transfer switches.
- B. Functional Description: Include the following functions for transfer switches:
 - 1. Indication of sources available, as defined by actual pickup and dropout settings of transfer switch controls.
 - 2. Indication of switch position.
 - 3. Indication of switch in test mode.
 - 4. Indication of failure of digital communications link.
 - 5. Key switch or user code access to control functions of panel.
 - 6. Control of switch test initiation.
 - 7. Control of switch operation in either directions
 - 8. Control of time delay bypass for transfer to normal source.
- C. Malfunction of annunciator, annunciation and control panel, or communications link shall not affect functions of transfer switch. In the event of failure of the communications link, transfer switch automatically reverts to standalone, self-contained operation. Transfer switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
- D. Remote Annunciation and Control Panel: Solid state components. Include the following features:
 - 1. Controls and indicating lights grouped together for each transfer switch.
 - 2. Label each indicating light control group. Indicate the transfer switch it controls, location of the switch and the load it serves.
 - 3. Digital Communications Capability: Matched to that of transfer switches supervised.
 - 4. Mounting: Flush modular, steel cabinet.
 - 5. Lamp Test: Lamp test switch on panel front.
 - 6. Power Source: Generator sets best battery.

2.6 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION – NOT USED

END OF SECTION 263600

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SECTION 265119 - INTERIOR LIGHTING - LED

PART 1 - GENERAL

1.1 SUMMARY

- A. Comply with the latest version of Title 24, Part 6 Energy Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Luminaire Manufacturers: Subject to compliance with the requirements of this Section and the design criteria specified in the Luminaire Schedule, provide products by the referenced product manufacturers listed in the Luminaire Schedule.
- B. Reference to specific luminaire manufacturers and their respective model or series numbers are included in the Luminaire Schedule to provide a guide as to the level of quality, performance, and overall physical appearance of the specified product, which shall be met, in accordance with the Luminaire Schedule's design criteria, and as written herein.
- C. Listed luminaire manufacturers and their series or model numbers shall not imply unconditional specification approval. The listed manufacturers and their respective products have been included only as acceptable manufacturers of the specified products. Modifications to a given manufacturer's standard product may be required to make the model or series numbers listed comply with the Luminaire Schedule's descriptions, design criteria, and these Specifications.
 - 1. The preceding paragraph shall in no way suggest, indicate, or imply that a manufacturer's UL/ETL listing be voided or otherwise compromised, in order to comply with the specified luminaire's design criteria, descriptions, or these Specifications.
- D. Luminaire Products and Accessory Manufacturers: Subject to compliance with the requirements of this Section, provide products from the referenced product manufacturers listed in the Luminaire Schedule, and as included herein.
 - 1. Unless otherwise stated in the Luminaire Schedule, luminaire components, light sources, drivers, controllers, and related accessories, shall be provided by the luminaire manufacturers, in compliance with their luminaire product listing.

2.2 REGULATORY REQUIREMENTS

- A. Provide luminaires factory designed, built, and tested per the following standards:
 - 1. Recessed Luminaires: In compliance with NEMA LE 4, for ceiling system material, type, and design compatibility.
 - 2. Solid State Lighting/Luminaires: UL 8750, 1598, 1574, and 2108.
- B. Luminaires and lighting products shall bear a UL or an ETL mark to prove qualification by a recognized NRTL. CE listing is not acceptable.
- C. 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.
- D. Solid State Lighting/Luminaires:
 - 1. Luminous flux, luminaire efficiency and chromaticity shall be tested, measured, and reported in accordance with the most current versions of IES documents LM-79 and LM-80.
 - 2. Chromaticity ranges for "white light" products, with various CCTs, shall be provided in accordance with ANSI/NEMA-C78.377.

3. Drivers and power supplies shall be provided in accordance with the requirements of ANSI/NEMA-C82.SSL1 and their maximum allowable harmonic emission limits shall be in accordance with ANSI/NEMA-C82.77.
4. Shall be provided with a U.S. Department of Energy (DOE) "Lighting Facts" or other label indicating their specific performance characteristics, tested, and reported in accordance with the requirements of the most current version of IES LM-79.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL or testing agency acceptable to Authorities Having Jurisdiction and marked for intended use.
- F. Except as otherwise specified herein, provide installation in accordance with the requirements of NECA/IESNA 500 – Standard for Installing Indoor Lighting Systems (ANSI).
- G. Hazardous (Classified) Location Luminaires: Provide luminaires designed, fabricated, and tested in compliance with:
 1. UL 844 – Luminaires for Use in Hazardous (Classified) Locations.
 2. Factory Mutual Global (FMG) certification.
 3. CEC Chapter 5, for specific hazard class, division, and location requirements.
- H. Tamper-resistant: Facility Guidelines Institute, Edition 7.2.
- I. Provide in compliance with NFPA 70.

2.3 LUMINAIRES AND ACCESSORIES

A. General Requirements:

1. Provide luminaires complete with the required and specified features, options, accessories, etc. Luminaires shall be provided as complete assemblies, ready for installation, including light source, power supplies, controllers, drivers, reflectors, shielding media, wiring and all other components required for a complete installation.
2. Luminaires provided shall be constructed, wired, and installed in compliance with appropriate NRTL standards and applicable codes.
3. Provide luminaires that are listed and approved for use in their application and location.
 - a. Products provided shall be listed and labeled, as defined by NFPA 70, by a NRTL, and shall be provided with the appropriate listing ID label(s) permanently affixed to the luminaire, concealed from normal view.
4. Except as otherwise noted, luminaires and their related accessories, light sources, power supplies, controllers, drivers, etc., shall be new, unused, factory tested, and ready for field installation.
5. Refer to Luminaire Schedule for additional luminaire specifications, descriptions, features and functions, color and finish selections, etc.
6. Recessed luminaires provided for installation in ceiling spaces known, or presumed, to be installed in direct contact with combustible materials within the ceiling cavity, shall be IC tested, rated, and so labeled.
7. Recessed luminaires provided for installation in known, or presumed airtight ceiling spaces, shall be designed to restrict airflow to under two cubic feet per minute, from the controlled environmental space to the ceiling space (or plenum), and shall be listed and labeled "Air-Tight."
8. Recessed luminaires provided for installation in known, or presumed fire rated ceiling assemblies, shall be UL classified, listed, and so labeled for use in fire rated ceiling assemblies.
9. Recessed luminaires shall be factory furnished with integral thermal protection devices, designed to automatically interrupt AC power applied to the luminaire light source(s).

10. Luminaires provided for recessed installations in accessible and inaccessible ceiling systems shall be designed and fabricated to provide access to, and field inspection of, concealed electrical components, serviceable parts, and wiring connections from below the finished ceiling system. Luminaire designs that require destruction, or removal of installed ceiling system components to gain access to, and inspection of, concealed electrical components, serviceable parts, and electrical connections, do not meet this specification.
 11. In general, luminaires shall be fabricated from sheet metal, or extruded metal parts. Except as otherwise specifically specified, noted, or indicated, non-metallic parts shall not be used in luminaire construction.
 12. Luminaires shall be constructed for safe installation. Luminaires shall be provided free from burrs, sharp edges and corners, and fabrication/tooling marks.
 13. Provide luminaires complete with ceiling trims, accessories, and similar materials, to coordinate with the actual ceiling construction materials scheduled to be installed.
 14. Provide luminaires complete with their full complement of required installation hardware, T-bar hangers, wood joist hangers, "C" channel bar hangers, outlet box canopies, pendant suspension kits, etc. The Contractor shall bear the responsibility for ceiling/luminaire installation coordination and procurement.
 15. Fixtures shall have serviceable components. Entire fixtures should not have to be replaced when one element no longer works.
- B. Recessed Luminaires: Comply with NEMA LE4 for luminaire/ceiling compatibility.
- C. Solid State Lighting Luminaires: Comply with UL 8750 and previously stated standards.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Factory Applied Labels: Comply with UL 1598. Include designated light source, controller and driver information. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when luminaires are installed in place.
1. Label shall provide the following information:
 - a. "USE ONLY" and include specific light source type.
 - b. Solid state lighting driver and dimming requirements.
 2. Provide DOE "Lighting Facts" or other label as described in Article 1.6 "Quality Assurance" on all solid state lighting products.
- G. Doors, Frames, and Other Access Components:
1. Doors, lens frames, access compartments, latches, etc., shall be smooth operating; designed and fabricated to trap produced light within the luminaire housing proper. No visible light leaks.
 2. Luminaires shall be designed, built, and tested to allow for light source replacement without having to remove or disassemble luminaire components.
 3. Lenses, louvers, diffusers, door frames, access covers, etc., shall be held captive, and shall be designed to limit the potential for accidental droppage during source replacement, luminaire cleaning, maintenance, etc.
- H. Luminaire Coatings and Finishes:
1. Luminaire surfaces, components, trims, housings, etc., shall be factory pre-treated, rust proofed, primed, and otherwise prepared, to inhibit rust and corrosion. Exposed luminaire surfaces shall be factory pre-treated, primed, and finish coated with a suitable rust and corrosion inhibiting product.

2. Luminaire reflective surface coatings shall provide not less than the following minimum reflectance values:
 - a. White Paint 85 percent
 - b. Specular Surfaces 83 percent
 - c. Semi-Specular Surfaces 75 percent
 - d. Laminated Silver Metalized Film 90 percent
 3. Except as otherwise indicated, provide the luminaire manufacturer's standard factory finish material(s). The finish material color shall be as specified or otherwise indicated.
 4. Where specifically specified, or otherwise indicated, custom finishes or color selections shall require written approval from the Architect prior to application. A sample of the custom finish or color shall be submitted, to the Architect, for approval.
 5. Where a specific finish material, finish, or color, is specified, or otherwise indicated, the luminaire manufacturer shall factory apply the stated finish or color product to all visible luminaire surfaces, except those surfaces affecting luminaire performance. Except as otherwise indicated, luminaire finishes shall not be field applied.
 6. Cast and extruded luminaire components and housings, specified with a natural or clear finish shall be factory coated with a baked-on, clear, methacrylate lacquer, transparent epoxy, or other suitable clear protective coating.
 7. Variations in exposed surface finishes on the same luminaire component are unacceptable and shall be reason enough for rejection and replacement at no cost to the Owner.
- I. Reflectors, Cones, and Baffles:
1. Shall be fabricated free from spinning lines, ripples, and other surface imperfections.
 2. Shall be designed for invisible and secure attachment and installation to luminaire housing.
 3. Shall be free from visible or exposed hardware.
 4. Shall be designed and fabricated to prevent light leakage from the luminaire itself, and from the surrounding attachment materials and surfaces.
 5. Shall be provided in the finish, color, material, and optical design properties specified in the Luminaire Schedule.
- 2.4 LENSES, DIFFUSERS, LOUVERS, AND SOURCE SHIELDING MEDIA
- A. General - Lenses and Diffusers:
1. Lenses shall be specifically designed, fabricated, and tested for the purpose of providing optically correct, measurable, and predictable light distribution results. Lenses shall facilitate light refraction, distribution, source shielding and glare control for artificial light source luminaires.
 2. Except as otherwise noted, shall be fabricated from 100 percent clear, UV stabilized, virgin acrylic, material, specifically designed and tested for use with artificial illuminating light sources, and shall be non-yellowing as a result of aging, exposure to heat, and UV radiation.
 3. Lens Thickness: Except as otherwise indicated, shall be fabricated and factory tooled to not less than 0.125 inch overall thickness.
 4. Shall be designed, fabricated, and tested to maintain a maximum smoke development rating of 450 as required by ASTM-E84, and a maximum burning rate of 2-1/2 inches per minute as required by ASTM D635.
 5. Deflection, measured at the center of a 24 inch x 48 inch lens or diffuser, from its edge, shall be not greater than 3/32 inch (0.094) below luminaire door/trim assembly. Negative cambers, molded into the lens or diffuser material, designed to arch the material upward, shall be acceptable.
- B. Pattern 19 Lens – Shall be:
1. Not less than .156 inches overall panel thickness.

2. Not greater than .080 inch prism penetration depth.
 3. Bold male (inverted) conical prisms, 3/16 inch square at penetration depth, straight flat-sided prism shape (concave sided, radiused prisms do not meet this specification), configured on a parallel/perpendicular 90 degree axis layout, across the entire panel.
 4. Acceptable Manufacturers: By luminaire manufacturer.
- C. Overlay Panel – Shall be:
1. Milk white, translucent acrylic material, nom. 0.040 inch thick, with a matte finish on the surface away from the source(s).
 2. Acceptable Manufacturers: By luminaire manufacturer.
- D. Glass Lenses and Diffusers: Annealed crystal glass unless noted otherwise.
1. Globes and Guards – Provided for protection of luminaires and their interior components.
 - a. Fabricated of shatterproof, heat and impact resistant materials, formed to luminaire contours, for integral and secure installation.
 - b. Cast guards shall be of copper free die-cast aluminum construction, formed to luminaire contours, for integral and secure installation.
 - c. Wire guards shall be formed wire, min. 16 AWG, spot welded at crossing intersections, and factory painted to match luminaire color, or non-painted stainless steel, where so specified.
 - d. Acceptable Manufacturers:
 - 1) By luminaire manufacturer.

2.5 ILLUMINATED "EXIT" LUMINAIRES

- A. Except as otherwise indicated, shall be solid, full face(s) fabricated from the specified material, with "EXIT" letters and directional chevrons stencil cut out of face material, and red acrylic sheet installed behind stencil cut.
- B. Where indicated to be edge-lit style:
1. Illuminated with red color LEDs.
 2. Sign face(s) fabricated from clear sheet acrylic material, with letters "EXIT" and directional chevrons engraved into face, filled in solid red color.
 3. Specular, Mylar sheet with silver mirror finish factory installed behind sign face(s), regardless of single or double face, so that "EXIT" cannot be read backwards.
- C. Under normal operating conditions, shall consume maximum of 5 watts of AC power, or less, per face.
- D. Unless indicated otherwise, shall be provided for AC operation, with multiple LEDs as the light source for internal illumination.
- E. Where indicated, shall be of the self-contained, AC/DC, integral battery standby operating type, with multiple LEDs as the light source for internal illumination in both modes of operation.
1. Battery: Sealed, maintenance free, nickel-cadmium type providing not less than 90 minutes of rated illumination time.
 2. Charger: Fully automatic, solid-state, constant current type, with integral, sealed transfer relay.
 3. Low Battery Disconnect: Provide a device and/or related circuitry that shall automatically disconnect the battery and protect it from deep/over discharge.

4. Operation: Under "normal" conditions the luminaire is illuminated via its integral sources, supplied from the AC voltage source, and the standby battery is in the float charge mode. Upon loss of AC voltage, or AC voltage falls below 80 percent of nominal system voltage, the integral transfer relay shall sense to the abnormal condition and automatically disconnect the luminaire lamps from the "normal" AC voltage source and transfer their operation to the standby battery voltage DC voltage source. Upon return of the "normal" AC voltage source, the integral transfer relay shall sense the return of "normal" AC voltage, and retransfer operation of the lamps back to the "normal" AC voltage source. The integral battery shall be returned to the charge mode.
 5. Test Push Button: Push-to-test type, integral to unit housing. Simulates loss of "normal" AC voltage, and initiates DC battery standby operation.
 6. AC Pilot Light: LED "ON" indicates normal AC power is connected. Normal pilot lamp intensity indicates unit is operating in the float charge mode. Bright pilot lamp intensity indicates unit is operating in the full charge mode.
- F. Integral Self-Test: Except as otherwise noted, illuminated "EXIT" sign luminaires shall be provided with integral self-test features and diagnostics.
1. Provide integral solid-state electronic circuitry and related components that shall:
 - a. Automatically initiate a one minute light source burn, battery discharge, and internal diagnostic test at least once every 30 days.
 - b. Automatically initiate a 30 minute light source burn, battery discharge, and internal diagnostic test once every 6 months.
 - c. Comply with the periodic testing requirement of the CEC Article 700, NFPA 110, and the local Authority Having Jurisdiction.
 - d. Provide positive, visual indications of unit malfunctions, during the self-testing routines, and during "normal" operating conditions.
 - e. Constantly monitor the proper operation of the luminaire charger and light source operation.
 2. In addition to the pre-programmed, self-testing, diagnostic routines, provisions for manual testing shall be provided.
 3. Equipment malfunctions diagnosed, shall be retained in permanent memory within the solid-state electronics, until corrected and reset.
- G. Standard Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which luminaire manufacturer agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within the specified warranty period.
- H. Acceptable Manufacturers:
1. Refer to Luminaire Schedule.
- ## 2.6 LIGHT SOURCES
- A. Acceptable Manufacturers:
1. Solid State:
 - a. Cree.
 - b. Citizen.
 - c. LG Innotek.
 - d. Nichia.
 - e. Osram Opto Semiconductor.
 - f. Philips Lumileds Lighting.
 - g. Samsung LED.
 - h. Seoul Semiconductor.
 - i. Bridgelux.

- j. Or as supplied by the luminaire manufacturer, in compliance with these Specifications.

2.7 LED LIGHTING PRODUCTS

A. General:

1. Refer to Luminaire Schedule for specified parameters such as correlated color temperature (CCT) value(s), delivered lumen output, efficiency, etc.
2. Products shall be fabricated to be Reduction of Hazardous Substances (RoHS)-compliant.
3. Must maintain their warranted life while operating within the manufacturers' specified environmental parameters.
4. The lumen value specification listed in the Luminaire Schedule is a delivered lumen value specification. Products supplied shall deliver not less than the lumen value specified.
5. The lumen maintenance specification of any assembled LED based chip, array, module, driver, and luminaire combination shall be a minimum of L₇₀, at 50,000 hours, as tested and measured in compliance with IES documents LM-79 and LM-80.
6. Except as otherwise stated in the Luminaire Schedule, the light source shall provide a minimum CRI of 80.
7. Products shall be binned to a maximum three step MacAdam Ellipse.

B. Drivers: Listed and labeled per UL 8750 and UL 1310 and shall meet or exceed the following general specification criteria:

1. Designed and tested to be compatible with the luminaire light source operating current, voltage, and output power requirements.
2. Inaudible above 27 dBA ambient sound level.
3. Designed, fabricated, and tested to operate at an input voltage of 120 – 277VAC, ±10 percent, at 60 Hz, with no perceptible change in light source output.
4. Contribute less than 20 percent total harmonic distortion, operating at full rated load, and shall not exceed the maximum allowable THD requirements allowed per standard ANSI C82.11.
5. Provided with integral short circuit, open circuit, and overload protection.
6. Have an operating power factor ≥ 0.9.
7. Limit conducted and radiated interference in compliance with FCC 47 CFR Part 15.
8. Housed in a UL compliant and listed enclosure, suitable for remote installation where required, and listed for installation within spaces used for environmental air (plenum), as defined in NFPA 70 – National Electrical Code.
9. Acceptable Manufacturers:
 - a. Cree.
 - b. EldoLED.
 - c. Philips/Advance.
 - d. Osram.
 - e. Thomas Research Products.
 - f. Or as supplied by the luminaire manufacturer, in compliance with these Specifications.

C. Continuous Dim Drivers - In addition to the general specification criteria specified above:

1. Have an operating power factor of ≥ 0.9 at full load, and not less than 0.8 at low dim level.
2. Provide smooth, flicker-free, dimmable light output from 100 percent to less than one (1) percent (perceived) if not otherwise indicated on the Luminaire Schedule.
3. 0-10VDC "current sinking" type dimming control protocol per enforced version of IEC Standard 60929, unless otherwise noted or required.
4. DMX compliant, where specified.

5. Acceptable Manufacturers:
 - a. Cree.
 - b. EldoLED.
 - c. Philips/Advance.
 - d. Thomas Research Products.
 - e. Or as supplied by the luminaire manufacturer, in compliance with these Specifications.

2.8 EMERGENCY LIGHTING PRODUCTS

A. Self-Contained, Emergency Lighting Battery Units (EBU):

1. Shall only be utilized in spaces with high ceilings, in stairwells and near egress doors. Coordinate with Project Team at start of design development for approved locations.
2. Description: Shall be self-contained, emergency lighting units complying with UL 924, and provided with the following features and functions:
 - a. Battery: Sealed, maintenance free, nickel-cadmium type, factory installed integral to the unit housing.
 - b. Charger: Fully automatic, solid-state type, with sealed transfer relay.
 - c. Operation: Under "normal" operating conditions, the units' light source is not illuminated, and the integral battery is in charge mode. Upon loss of AC voltage, or AC voltage falling below 80 percent of nominal system voltage, the integral transfer relay shall sense the abnormal condition, and automatically apply integral battery standby/emergency power to the units' light source; providing rated illuminance for not less than 90 minutes, or until "normal" AC power is restored, if outage duration is less than 90 minutes. Upon return of "normal" AC power, the integral transfer relay shall sense the return of "normal" AC voltage and shall automatically disconnect battery power from the units' light source, and the battery shall be returned to the charge mode.
 - 1) Integral battery shall provide not less than 90 minutes of rated illumination time.
 - d. Test Push Button: Shall be push-to-test, integral to the luminaire housing. Shall simulate loss of "normal" AC power, and initiate DC battery standby operation.
3. Integral Self-Test: Except as noted, provide with integral self-test feature and diagnostics. Provide the following:
 - a. Luminaires shall be provided with integral solid-state electronic circuitry and related components that shall:
 - 1) Automatically initiate a one minute light source burn, battery discharge, and internal diagnostic test once every 30 days.
 - 2) Automatically initiate a 30 minute light source burn, battery discharge, and internal diagnostic test once every 6 months.
 - 3) Comply with the periodic testing requirement of the CEC Article 700, NFPA 110, and the local Authority Having Jurisdiction.
 - 4) Provide positive, visual indications of unit malfunctions, during the self-testing routines, and during "normal" operating conditions.
 - 5) Constantly monitor the proper operation of the luminaire charger and light source operation.
 - b. In addition to the pre-programmed, self-testing, diagnostic routines, luminaires provided shall provide for manual testing, providing user controls to initiate luminaire testing.

- c. Equipment malfunctions diagnosed, shall be retained in permanent memory within the solid-state electronics, until corrected and reset.
 - 4. Environmental Provisions: Provide products for continuous operation under the following operating conditions:
 - a. Ambient Temperature: Less than 0 deg. F (minus 18 deg. C) or exceeding 104 deg. F. (40 deg. C) with an average temperature exceeding 95 deg. F (35 deg. C) over a 24 hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg. F (minus 20 deg. C) and not exceeding 140 deg. F (60 deg. C)
 - c. Humidity: Greater than 95 percent (condensing).
 - d. Altitude: Exceeding 3300 ft. (1000m) .
 - 5. Shall be designed, tested, and fabricated to be in compliance with RoHS requirements.
 - 6. Protection: Heavy gauge, chrome-plated, or painted steel wrap around cage to protect entire unit.
 - 7. Warranty: Contractor shall provide a full, no cost, replacement warranty during their contracted guarantee period. After the contractors guarantee period, the equipment manufacturer shall provide a pro-rated reduced cost warranty for not less than 9 years.
 - 8. Referenced Products:
 - a. Refer to Luminaire Schedule.
- B. "Push-To-Test" Devices:
 - 1. For luminaires scheduled, specified, or otherwise indicated with remote test stations, the test switch and pilot light shall be factory assembled on a standard, single gang, white stainless steel cover plate, designed for installation over a single gang electric box opening.
 - 2. Where remote Push-to-Test devices and their locations are not specifically shown, or otherwise indicated, a test switch/pilot light assembly shall be either factory installed, or field installed on the luminaire.
 - 3. Contractor shall provide field wiring between test device locations and the emergency lighting device.
- C. EMERG/LED Emergency Lighting Devices for LED Luminaires:
 - 1. Where indicated, scheduled, or shown, provide single, self-contained emergency lighting inverters designed specifically for installation within, immediately adjacent to, or remote from a given LED luminaire.
 - 2. Shall be provided with the following performance specifications, features, and requirements:
 - a. Integral Battery: Maintenance free, nickel cadmium type.
 - b. Charger: Integral to housing, solid-state type, designed, built, and tested to recharge a fully discharged battery in not more than 24 hours.
 - c. Inverter: Integral to housing, sinusoidal 60 Hz rectifier/inverter.
 - d. AC voltage sensing circuitry and transfer relay.
 - e. Metal "F" can enclosure designed for remote installation from luminaire.
 - f. Test switch and pilot/charger indicator light.
 - 3. Shall be UL listed for factory or field retrofit, in accordance with Underwriter's Laboratories Standard 924 – Emergency Lighting and Power Equipment.
 - 4. Shall be designed, built, and tested for dual input voltage compatibility – 120/277VAC, 60 Hz.
 - 5. Shall be designed, tested, and fabricated to be in compliance with RoHS requirements.
 - 6. Devices designated, or otherwise indicated, to be installed remote from a given luminaire housing, shall be provided with a listed and approved remote mounting enclosure.

7. Operation: Those luminaires specified with emergency lighting devices shall:
 - a. Under "normal" operating conditions - the device shall provide AC input to the given luminaires' integral or remotely installed driver, and the battery shall be charged.
 - b. Under a "power fail" mode – the device integral voltage sensing circuit shall sense loss of "normal" AC power, and transfer operation of the device to integral battery power, maintaining the AC input to the luminaire, allowing the luminaire to operate at the device's rated lumen output, for not less than 90 minutes, or until "normal" AC power is restored, if outage duration is less than 90 minutes.
 - c. Upon restoration of "normal" AC power, the device integral voltage sensing circuit shall sense the return of "normal" AC power, and the device integral transfer relay shall automatically re-transfer operation of the device from integral battery to "normal" AC power input to the luminaire driver. The device shall automatically revert back to battery charge mode.
 - d. The device shall allow the connected luminaire to be switched (ON/OFF) or dimmed, under "normal" operating conditions, and regardless of switch position or dimmed light level, shall, upon loss of "normal" AC voltage, provide illumination to the devices rated lumen output.
 - e. Provide not less than 90 minutes of rated illumination time, from the integral battery.
8. Where shown, indicated, or otherwise noted, provide low temperature emergency lighting devices as follows:
 - a. Designed, tested, and fabricated to operate the designated luminaire(s) in an ambient temperature range of -20 degrees C to +60 degrees C (-4 degrees F to +140 degrees F).
9. Rated Load Output: Not less than 20W total (including luminaire ballast/driver losses) at 120/277VAC, 60 Hz.
10. Provide devices complete with remote test station:
 - a. Remote test station shall be a single pole, momentary contact, push button switch, and a red, charge indicator LED light, factory installed on a single gang, white stainless steel coverplate, engraved and filled to read "PUSH TO TEST", and "CHARGING INDICATOR".
 - b. Contractor shall provide field wiring between the remote test switch station locations and the emergency lighting device locations.
11. Warranty: Five (5) year full product replacement (not pro-rated) warranty against defects in manufacture or installation.
12. Referenced Product:
 - a. The Bodine Company - ELI Series/BSL722 COLD for cold environment installations.
 - b. Or equivalent.

2.9 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports" 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 luminaire.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as luminaire.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge (2.68 mm).

- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge (2.68 mm).
- F. Luminaire Support Chains: Not less than #12 chain link style, provided with "S" hooks for linking chain lengths together, and fastening devices to allow for independent attachment and anchoring to building structure.
- G. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- H. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.10 EXTRA MATERIALS

- A. Above and beyond the quantities of material required to execute the contract, furnish the following extra materials:
 - 1. Spare luminaires:
 - a. For fixture types with installed quantities of at least 100 units, furnish quantity equal to five (5) percent of the number of units of each type installed as attic stock.
 - b. Type – Qty .
 - c. Type – Qty .
 - d. Type – Qty .
 - 2. Spare Drivers/Components:
 - a. Furnish at least one (1) spare driver for every luminaire type installed, and one (1) additional spare driver for every 24 products installed.
 - b. Type – Qty .
 - c. Type – Qty .
 - d. Type – Qty .
 - 3. Spare Emergency Lighting Products:
 - a. Self-contained Emergency Lighting Battery Units (EBU) - Qty. .
 - b. EMERG/LED - Qty. .
- B. Extra materials shall be delivered, in packages with protective covering, to the Owner, and shall be labeled, clearly identifying the contents.
- C. Provide proof of delivery. Obtain a receipt, or other means of proof, from the [Owner, indicating that the extra materials have been delivered, and received by whom.

PART 3 - EXECUTION – NOT USED

END OF SECTION 265119

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SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Comply with the latest version of Title 24, Part 6 Energy Code.

PART 2 - . PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with the requirements of this section and the design criteria specified in the Luminaire Schedule, provide products by the manufacturers listed in the Luminaire Schedule.
- B. Reference to specific manufacturers and their respective model or series numbers are included in the Luminaire Schedule to provide a guide as to the level of quality, performance, and overall physical appearance of the specified product, which shall be met, in accordance with the Luminaire Schedule's design criteria, and as written herein.
- C. Listed manufacturers and their series or model numbers shall not imply unconditional specification approval. The listed manufacturers and their respective products have been included as acceptable manufacturers of products which shall comply with the Luminaire Schedule design criteria, luminaire, pole and accessory descriptions, and these specifications. Modification to a given manufacturer's standard product may be required to make the model or series numbers listed comply with the Luminaire Schedule design criteria, and these specifications.
 - 1. The preceding paragraph shall in no way suggest or indicate that a manufacturer's UL listing be voided or otherwise compromised, in order to comply with the specified luminaire design criteria, descriptions or these specifications.
- D. Manufacturers of products not specifically listed in the Luminaire Schedule or submitting on the basis of "or equivalent", or "as approved", shall provide the following for review prior to, or along with product submission.
 - 1. Documentation showing a minimum of three (3) years' experience in the business of the design and manufacture of lighting equipment similar to the type and quality of products specified.
 - 2. Product data and photometry demonstrating conformance with these specifications and the specific data included in the Luminaire Schedule.
 - 3. Prototype and/or operating sample of the product for evaluation by the Architect/ Engineer. Prototype and/or sample shall be sufficiently detailed and operational to allow for fair evaluation and to demonstrate compliance with the salient features specified. Product data and shop fabrication drawings are not acceptable means of providing prototype/sample requirement.
 - 4. Architect/Engineer shall be the sole judge of compliance and reserves the right to disapprove manufacturer's products other than what has been previously specified.
- E. Source Limitations:
 - 1. Except as otherwise specified in the Luminaire Schedule, or as specifically noted elsewhere, similar exterior lighting products shall be procured from a single manufacturer.
 - 2. Except as otherwise specified in the Luminaire Schedule, or as specifically noted elsewhere, similar exterior lighting products shall be procured with the same finish, color, materials, and physical properties to maintain a consistent level of quality and appearance.

2.2 REGULATORY REQUIREMENTS

- 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. Solid State Lighting/Luminaires:
 - 1. Luminous flux, luminaire efficiency and chromaticity shall be tested, measured, and reported in accordance with the most current versions of IES documents LM-79 and LM-80.
 - 2. Chromaticity ranges for "white light" products, with various correlated color temperatures, shall be provided in accordance with ANSI/NEMA-C78.377.
 - 3. Drivers and power supplies shall be provided in accordance with the requirements of ANSI/NEMA-C82.SSL1 and their maximum allowable harmonic emission limits shall be in accordance with ANSI/NEMA-C82.77.
 - 4. Shall be provided with a U.S. Department of Energy (DOE) "Lighting Facts" label indicating their specific performance characteristics, tested, and reported in accordance with the requirements of the most current version of IES LM-79.
- 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. Hazardous (Classified) Location Luminaires: Provide luminaires designed, fabricated, and tested in accordance with:
 - 1. UL 844 – Luminaires for used in Hazardous (Classified) locations.
 - 2. Factory Mutual Global (FMG) certification.
 - 3. CEC Chapter 5, for specific hazard class, division, and location requirements.
- E. Comply with IEEE C2, "National Electrical Safety Code."
- F. Comply with NFPA 70.

2.3 LUMINAIRE AND SUPPORT PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.4 LUMINAIRES - GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled (and defined in NFPA 70) for installation in wet locations, or equivalent IP rating, by an NRTL acceptable to Authorities Having Jurisdiction.
- B. FM Global Compliance: Provide luminaires for hazardous locations that are listed and labeled for their Class, Division, and locations, by FM Global.
- C. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Corrosion resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

- F. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- 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. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- H. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat and UV radiation.
 - 2. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- I. Exposed Hardware Material: Stainless steel.
- J. Non-Metallic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- K. Factory-Applied Labels: Comply with UL 1598. Include recommended light source, ballasts, and driver information. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when luminaires are in place.
 - 1. Label shall provide the following information:
 - a. "USE ONLY" and include specific light source type.
 - b. CCT and CRI for all lamps.
 - c. Solid state lighting driver and dimming requirements.
 - 2. Provide DOE "Lighting Facts" label on all solid state lighting products.
- L. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- M. 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.
- N. Lenses and Refractors Gaskets: Use heat and aging resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- O. Luminaire Finishes and Colors: Except as otherwise noted or specified, apply manufacturers standard paint finish to factory assembled luminaire before shipping. Where indicated, provide custom finish process and custom color specified.
- P. 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. Factory painted finish, consisting of one or more coats of primer and finish coats of TGIC colored powder coating and clear protective coats.
 - a. Color: White, or otherwise specified by Project Team.

2.5 LUMINAIRES - LED

- A. Refer to Luminaire Schedule for specified parameters such as correlated color temperature (CCT) value(s), lumen output, efficiency, etc.
- B. Products shall be fabricated to be Reduction of Hazardous Substances (RoHS)-compliant.

- C. Must maintain their warranted life while operating within the manufacturers' specified environmental parameters.
- D. The lumen value specification listed in the Luminaire Schedule is a delivered lumen value specification. Products supplied shall deliver not less than the lumen value specified.
- E. The lumen maintenance specification of any assembled LED based chip, array, module, driver, and luminaire combination shall be a minimum of L_{70} , at 50,000 hours, as tested and measured in compliance with IES documents LM-79 and LM-80.
- F. Except as otherwise stated in the Luminaire Schedule, the light source shall provide a minimum CRI of 80.
- G. Exterior fixtures shall not have a stab connection. All power connections shall be shrink wrapped, soldered, and caulked.
- H. Drivers: Listed and so labeled per UL 8750 and UL 1310, and shall meet or exceed the following general specification criteria:
 - 1. Designed and tested to be compatible with the luminaire light source operating current, voltage, and output power requirements.
 - 2. Inaudible above 27 dBA ambient sound level.
 - 3. Designed, fabricated, and tested to operate at an input voltage of 120 – 277VAC, ± 10 percent, at 60 Hz, with no perceptible change in light source output.
 - 4. Contribute less than 20 percent total harmonic distortion, operating at full rated load, and shall not exceed the maximum allowable THD requirements allowed per standard ANSI C82.11.
 - 5. Provided with integral short circuit, open circuit, and overload protection.
 - 6. Have an operating power factor ≥ 0.9 .
 - 7. Limit conducted and radiated interference in compliance with FCC 47 CFR Part 15.
 - 8. Housed in a UL compliant and listed enclosure, suitable for remote installation where required, and listed for installation within spaces used for environmental air (plenum), as defined in NFPA 70 and California Electrical Code.
 - 9. Manufacturers:
 - a. Cree.
 - b. EldoLED.
 - c. Philips/Advance.
 - d. Thomas Research Products.
 - e. Or as supplied by the luminaire manufacturer, in compliance with these Specifications.

2.6 PHOTOELECTRONIC CONTROLS INTEGRAL TO LUMINAIRE

- A. Integral, Luminaire Installed, Photocell:
 - 1. Where specified, scheduled and or otherwise indicated, provide a photo-electronic device designed, built, and tested to provide automatic, ON/OFF, dusk to dawn control of an individual luminaire, based on ambient daylight level.
 - 2. Shall be UL 773A listed and fabricated to meet or exceed the requirements of ANSI C136.10, with integral relay contacts rated not less than 1000 VA to a ballasted load at not less than 300VAC.
 - 3. Provided with integral time delay feature to prevent false operation after momentary light flashes or light blockages.
 - 4. Reference Product: By luminaire manufacturer.

2.7 DIMMING CONTROL – LED LUMINAIRES

- A. Shall be solid-state, electronic devices that provide an automatic means to daily dim the lighting level of individual LED luminaire arrays for a user selectable period of time during their total daily ON operating hours.
 - 1. Dimming shall be 0-10V interface.
 - 2. Dimmed output levels shall be user selectable from 10–100 percent total LED array light output.
 - 3. Dimmable hours shall be user selectable from a minimum of 4 hours daily, to a maximum of 8 hours daily, based on the total number of ON hours. (EX: If the total number of luminaire operating hours on a given day is 12 hours, automatic dimming can be user selectable to dim for a minimum of 4 out of the 12 total hours, to a maximum of 8 out of the 12 total hours.)
- B. The user selectable dimmable hour duration shall always occur during the midpoint of the total number of ON hours. (EX: If the total number of ON hours on a particular day is 10 hours (8PM – 6AM), the 4 minimum dimming hours would occur between the hours 11PM – 3AM. If the 8 maximum dimming hours were selected for the same day, the dimmed hours would occur between 9PM – 5AM.)
- C. The dimming control device shall have no control over the total ON hours of operation. The luminaire ON/OFF times shall be set via a photoelectric control device, or time switch, not the dimming control device.
- D. The dimming control device shall automatically sense the daily ON/OFF times and shall automatically calculate the midpoint of the total ON hours of operation. The ON/OFF times shall vary daily throughout the year, and the daily midpoint dimming hours shall vary accordingly with the daily ON/OFF times.
- E. The dimming light levels and time durations shall be user selectable via software. The software shall be free of charge to the Owner and shall be either turned over to the Owner for their use or may be downloaded free of charge from the manufacturer's website.
- F. The dimming control device shall be a standalone product designed, fabricated, and tested to be either factory or field installed within a given luminaire's housing, or its support structure. Device shall be:
 - 1. Self-contained in an IP66 housing.
 - 2. Provided with wiring leads or clamping style connectors for connecting line voltage wiring (120-277VAC) and 0-10V wiring to LED driver.
 - 3. Provided with a pluggable connector and USB cable for connection to Owner/Contractor-supplied PC, or Contractor-supplied handheld programming device, for loading, installing, and programming the software.
- G. Reference Product:
 - 1. Philips – Dynadimmer 0-10V.

2.8 MOTION SENSING CONTROL – LED LUMINAIRES

- A. Shall be solid-state, electronic devices that under "normal" operating conditions, dim the light output of their connected LED luminaire arrays, until motion is sensed. Upon detecting nearby motion, the devices undim their respective luminaires and allow them to operate at full lumen output. After a user selectable time period of sensing no more motion, the device reverts control of the luminaire to the previously set dim level.

- B. The device shall utilize passive infrared technology for motion sensing.
 - 1. 180-degree coverage pattern.
 - 2. Shall detect major motion within a 30 ft. circle, at an installed height of 20 ft. above grade.
- C. Upon sensing no motion, the device shall provide a user variable 0-10V input to the connected luminaire driver. The user variable 0-10V input may be change from 0V (OFF) to 9.8V.
 - 1. Unless otherwise directed by the Owner, device shall be factory set to 1V (10% light output) when no motion is sensed.
- D. The device shall provide for a variable high to low light output time delay. Upon sensing motion, the device shall allow operation of the luminaire to 100% (high) light output. After some user variable period of time, the device shall revert the luminaire to its low (dimmed) level of operation. The time to revert back to low level shall be variable from 5-30 minutes.
 - 1. Unless otherwise directed by the Owner, device shall be factory set to 10-minute time delay.
- E. The motion sensing control device shall have no control over the total ON hours of operation. The luminaire ON/OFF times shall be set via a photoelectric control device, or time switch, not the motion sensing control device.
- F. The device shall be provided with an integral daylight sensor that shall detect the ambient daylight condition present at any given time and shall keep the luminaire output at the low light level, regardless of sensing motion, if the measured daylight level is at or above the sensors variable set point.
 - 1. Daylight light level set point shall be variable between 1-250 footcandles.
- G. The device shall provide for user selectable sensitivity, to reduce/increase motion detection within the device's coverage ranges.
 - 1. Unless otherwise directed by Owner, device shall be factory set to MAX.
- H. Provide for the Owner, a wireless, handheld, programming device for their use in future programming activity. The handheld programming device shall provide menu driven software for programming and configuring the motion sensing control devices.
- I. Reference Product:
 - 1. Philips – Programmable Motion Response (Prog MR) with wireless handheld programming device.

2.9 POLE AND LUMINAIRE SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 - 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 Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 - 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. Comply with requirements in Division 26 Sections "Hangers and Supports" and "Boxes and Cabinets" for luminaire supports for other than pole mount applications.

- D. 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 stainless steel items are indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- E. Concrete Support Foundations: May be cast in place or factory precast.
 - 1. Refer to drawing details for cast in place foundation dimensional and construction requirements.
 - a. Concrete shall be not less than 4,000 psi @ 28 days, 5-9 percent entrained air.
 - b. Anchor bolts specific to the design of the exterior lighting poles shall be furnished to the Contractor for installation and embedment within the pole foundations.
 - c. Contractor shall provide raceways, grounding electrodes, and other electric work relating to the pole foundations.
 - 2. Refer to Division 03 Section "Cast-in-Place Concrete" for earthwork, concrete, reinforcement, formwork, and erection specifications.
 - 3. Foundation on bollards shall be at least 4-inches above finished grade.
 - 4. Factory precast foundations shall be fabricated to the dimensional and construction requirements indicated on the drawing details.
 - a. Anchor bolt specifications, specific to the design of the exterior lighting poles, shall be provided to the precast fabricator for their installation and embedment within the precast pole foundations.
 - b. Raceway requirements (size, quantity, and locations) shall be provided by the Contractor, to the precast fabricator, for installation and embedment with the precast pole foundations.
 - c. Precast concrete foundation designs shall be engineered by a professional structural engineer, licensed in the locale, and shall be so identified.
- F. Power Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- G. No cast plates are allowed, utilize stainless steel.

2.10 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
 - 1. Shape: Round tapered.
 - 2. Erection Provisions: Butt flange for bolted installation on foundation or breakaway support.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Handhole: Provide handhole opening, nominal 3 inch by 5 inch, at approximately 18 inches above pole base, complete with weathertight cover and securing fastener.

- E. Grounding and Bonding Lugs: Welded 1/2 inch (13 mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding" listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- F. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, and 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.
- G. 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. 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.
 - 3. Factory painted finish, consisting of one or more coats of primer and finish coats of TGIC colored powder coating and clear protective coats.
 - a. Color: White, unless otherwise specified by Project Team.

2.11 POLE ACCESSORIES

- A. Receptacle Provision: Provide opening in pole shaft to allow for the flush and concealed installation of a duplex GFCI type receptacle and lockable WP cover by the Contractor. Refer to Division 26 Section "Wiring Devices" for requirements.
 - 1. 18 inches (460 mm) above finished grade.
- B. Base Covers: Manufacturers' standard metal units, arranged to cover pole's anchor bolts and nuts. Finish and color same as pole.
- C. Decorative accessories, supplied by decorative pole manufacturer, include the following:
 - 1. Banner Arms: **<Insert material.>**

PART 3 - EXECUTION – NOT USED

END OF SECTION 265600

SECTION 270538 - WIRE BASKET TYPE CABLE TRAYS

PART 1 - PRODUCTS

1.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. B-Line Systems, Inc.
 2. Chatsworth Products, Inc.
 3. Cablofil, Inc., a subsidiary of Legrand.
 4. WBT, LLC.

1.2 CABLE TRAYS, GENERAL REQUIREMENTS

- A. Cable tray systems shall be of indicated types, sizes, and NEMA classes and shall be complete with manufacturer's recommended covers, barrier strips, dropouts, fittings, conduit adaptors, hold-down devices, grommets, and blind ends as required and indicated.
- B. Cable tray equipment shall include pre-manufactured bends, tees, intersections, etc. Field modifications of tray will not be acceptable.
- C. Cable tray products shall have rounded edges and smooth surfaces.

1.3 MATERIALS AND FINISHES

- A. Cable Tray Materials:
1. Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent and surface treated after manufacture.
- B. Cable Tray Finishes:
1. Finish for carbon steel wire after welding and bending of mesh.
 - a. Electrodeposited Zinc Plating: ASTM B 633, Type III, SC-1.
 - b. Hot Dipped Galvanized: Pre-galvanized wire in accordance with ASTM A641-89.
 - c. Powder Coat Finish: In accordance with AAMA 2604. Eliminates VOCs in atmosphere during manufacturing process.
 - d. Epoxy coated, painted finished, resin based paint applied non-tray and then dried/cured in oven.
 - e. Stainless Steel: In accordance with ASTM A580.
- C. Cable tray shall consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL classified splices where tray acts as equipment grounding conductor. Wire mesh cable tray shall have continuous welded top side wire to protect cable insulation and installers.
1. Cable tray shall only consist of radial bends allowing free-forming cable bends of 10 times cable diameter. 90-degree bends are not permitted.
- D. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.
- E. Color shall be black matte finish.

1.4 SIZES AND CONFIGURATIONS

- A. Wire Mesh: 2 inches by 4 inches (50 x 100 mm).
- B. Cable Tray Depth: 4 inches (105 mm).

- C. Cable Tray Width: 12 inches (300 mm).
- D. Wire Diameter: Patented design includes varying wire sizes to meet application load requirements; to optimize tray strength; and to allow tray to remain lightweight (5 mm thickness minimum).

1.5 FASTENERS FOR SUPPORTS

- A. Fasteners to connect cable tray supports to the building structure shall be as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All-steel springhead type.
 - 3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

1.6 CABLE TRAY ACCESSORIES

- A. Cable Drop-Outs or Waterfalls:
 - 1. Sizes to cable tray width for cable bundle distribution.
 - 2. Category 6 compliant (meeting minimum bend radius).
 - 3. Same material and finish as cable tray.
- B. Fittings: Pre-manufactured tees, crosses, risers, elbows, and other fittings of same materials and finishes as cable tray.
- C. Conduit to Cable Tray Adaptors: U clamp type, of same material and finish as cable tray.

1.7 FIRESTOPPING

- A. General: Materials shall be UL listed and labeled and FM approved for fire and smoke ratings consistent with penetrated barriers, per Division 07 and Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
 - 1. Sleeves per Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

1.8 WARNING SIGNS

- A. Lettering: 1-1/2 inch high, black on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- B. Materials and Fastening: Conform to Division 26 Section "Electrical Identification."

PART 2 - EXECUTION

END OF SECTION 270538

SECTION 271000 - STRUCTURED TELECOMMUNICATIONS CABLING SYSTEMS

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 FIBER OPTIC CABLING

- A. General: All Fiber Optic Cabling installed shall meet or exceed the following requirements as well as the requirements listed under the specific application of the cable:
 - 1. All fiber optic cabling shall be new and installed one (1) year within date of manufacture.
 - 2. All fiber optic cabling shall be UL listed for its required application.
 - 3. Fiber optic cabling manufacturer shall certify that Maximum Attenuation is measured in accordance with ANSI/EIA/TIA 455-46, -53, -61.
 - 4. Fiber optic cabling manufacturer shall certify that Transmission Capacity is measured in accordance to ANSI/EIA/TIA 455-51, -30, -54.
- B. Indoor Fiber Optic Cabling:
 - 1. Cable Type – Multimode 50/125 μm :
 - a. Core type shall be laser certified for optimal distance parameters. Graded index glass shall be ISO/IEC 11801 OM4 grade.
 - b. Core Diameter: 50 (+3) μm .
 - c. Clad Diameter: 125 (+2) μm .
 - d. Numerical Aperture: 0.208 μm .
 - e. Maximum Attenuation:
 - 1) 850nm Wavelength: 3.0 dB.
 - 2) 1300nm Wavelength: 1.0 dB.
 - f. Minimum Overfilled Launch (OFL) Bandwidth (MHz-Km):
 - 1) 850nm Wavelength: 3500.
 - a) Minimum Effective Modal Bandwidth (EMB): 4700.
 - 2) 1300nm Wavelength: 500.
 - g. Serial 1 Gigabit Ethernet:
 - 1) 850: 1100m.
 - 2) 1300: 600m.
 - h. Serial 10 Gigabit Ethernet:
 - 1) 850: 550m.
 - i. Operating Temperature: -20 degrees - +50 degrees C.
 - j. The fiber optic cabling shall have an armored exterior jacket with a 900 μm tight buffer jacket and an outer heather violet or magenta exterior jacket with identifiable cable markings.
 - k. Fiber optic cable shall comply with ANSI/TIA/EIA 492AAAE.
 - l. Fiber optic cable shall comply with IEEE 802.3aq standard for gigabit Ethernet.
 - m. Fiber optic cable shall meet or exceed EIA/TIA 568-3.D measurement of bandwidth on multimode fiber (FOTP-204) utilizing restricted mode launch.
 - n. Indoor fiber optic cables shall comply with ANSI/ICEA S-82-596 standard for fiber optic premises distribution cable.
 - o. Cable shall be suitable for installation in a plenum application.

- p. **[24 AND 48]-Strand Fiber Optic Cabling:**
 - 1) Manufacturers:
 - a) Panduit FOPRZ24Y, FONRZ48Y .
- 2. Cable Type – Single Mode Fiber Optic Cabling:
 - a. Dispersion – ISO/IEC 11801 OS2 unshifted single mode type.
 - b. Core Diameter: 8.2 um.
 - c. Clad Diameter: 125 um; +1 um.
 - d. Core/Clad Concentricity: <.5 um.
 - e. Maximum Attenuation:
 - 1) 1310nm Wavelength: .65 dB.
 - 2) 1383nm Wavelength: .65 dB.
 - 3) 1550nm Wavelength: .65 dB.
 - f. Serial 1 Gigabit Ethernet:
 - 1) 1310: 5000m.
 - g. Serial 10 Gigabit Ethernet:
 - 1) 1310: 10000m.
 - 2) 1550: 40000m.
 - h. Operating Temperature: -40 degrees - +70 degrees C.
 - i. The fiber optic cabling shall have a 900 um tight buffer jacket and a yellow exterior jacket with identifiable cable markings.
 - j. Fiber optic cable shall comply with TIA/EIA – 492CAAA.
 - k. Indoor fiber optic cables shall comply with ANSI/ICEA S-82-596 standard for fiber optic premises distribution cable.
 - l. Cable shall be suitable for installation in a plenum application.
 - m. **[24-Strand Fiber Optic Cabling:**
 - 1) Manufacturers:
 - a) Panduit FSPR924Y .
- C. Indoor/Outdoor Fiber Optic Cabling:
 - 1. Single Mode:
 - a. Dispersion - ISO/IEC 11801 OS2 unshifted single mode type.
 - b. Core Diameter: 8.2 um.
 - c. Clad Diameter: 125 um.
 - d. Maximum Attenuation:
 - 1) 1310nm Wavelength: .4 dB.
 - 2) 1383nm Wavelength: .4 dB.
 - 3) 1550nm Wavelength: .3 dB.
 - e. Serial 1 Gigabit Ethernet:
 - 1) 1310: 5000m.
 - f. Serial 10 Gigabit Ethernet:
 - 1) 1310: 10000m.
 - 2) 1550: 40000m.
 - g. Operating Temperature: -40 - +70 degrees C.

- h. The fiber optic cabling shall be a gel-filled, loose-tube cable with an exterior jacket with identifiable cable markings and suitable for the specific application.
 - 1) Gel free cable with water blocked by water swellable yarn and tape.
 - 2) Polyethylene jacket for weather and UV protection.
 - 3) All dielectric central strength member.
 - i. Fiber optic cable shall comply with ANSI/TIA/EIA 492CAAA.
- 2. Manufacturers:
 - a. Corning 012ESF-T4101DA1 (12-Strand(OS2))
- 3. Multimode 50/125 um:
 - a. Core type shall be laser certified for optimal distance parameters. Graded index glass shall be [OM3] [grade.
 - b. Core Diameter: 50 (+3) um.
 - c. Clad Diameter: 125 (+2) um.
 - d. Numerical Aperture: 0.208 um.
 - e. Maximum Attenuation:
 - 1) 850nm Wavelength: 3.0 dB.
 - 2) 1300nm Wavelength: 1.0 dB.
 - f. Minimum Overfilled Launch (OFL) Bandwidth (MHz-Km):
 - 1) 850nm Wavelength: 3500.
 - a) Minimum Effective Modal Bandwidth (EMB): 4700.
 - 2) 1300nm Wavelength: 500.
 - g. Serial 1 Gigabit Ethernet:
 - 1) 850: 1100m.
 - 2) 1300: 600m.
 - h. Serial 10 Gigabit Ethernet:
 - 1) 850: 550m.
 - i. Operating Temperature: 40 degrees - +70 degrees C.
 - j. Fiber optic cable shall comply with ANSI/TIA/EIA 492AAAE.
 - k. Fiber optic cable shall meet or exceed EIA/TIA 568-3-D measurement of bandwidth on multimode fiber (FOTP-204) utilizing restricted mode launch.
 - l. The fiber optic cable shall be a dry, water blocking, loose-tube cable with an exterior jacket with identifiable cable markings and suitable for the specific application.
 - 1) Gel free cable water blocked by water swellable yarn and tape.
 - 2) Polyethylene jacket for weather and UL protection.
 - 3) All dielectric central strength member.
- 4. Indoor/Outdoor fiber optic cables shall comply with ANSI/ICEA S-82-596 Standard for Premises Distribution Cable.
- 5. Fiber optic cable shall comply with IEEE 802.3aq standard for 10 gigabit Ethernet.
- 6. Provide a hybrid/composite cable consisting of the following:
 - a. [12strand single mode.
 - b. [12 -strand multimode (50/125).
- 7. Manufacturers:
 - a. Corning 012TSF-T4180DA1 (12-Strand (OM3))
 - b.

2.2 EXTENDED FREQUENCY COPPER DATA CABLING

- A. General: All copper data cabling installed shall meet or exceed the following requirements as well as the requirements listed in the specific application of the cable:
1. All copper data cabling shall be new and installed one (1) year within date of manufacture.
 2. All copper cabling shall be UL listed for its required application.
 3. All horizontal copper cabling referred to in these specifications or on Drawings as data cabling, copper cabling, UTP shall be Category 6 data cabling as specified herein.
 - a. Category 6 structured cabling system must be backward compatible with Category 5 and Enhanced Category 5 cabling and components.
 4. All horizontal copper cabling referred to in these specifications or on Drawings as data cabling, copper cabling, F/UTP shall be Category 6A data cabling as specified herein.
 - a. Category 6A structured cabling system must be backward compatible with Category 6 and Enhanced Category 5 cabling and components.
 5. Exceed all channel performance requirements for TIA-568-C.2-1 to support IEEE 802.3an standard for 10 gigabit Ethernet.
- B. Category 6A Screened (F/UTP) - Horizontal Cable:
1. High performance unshielded twisted pair cable capable of data transmission speeds of 10,000Base-T, 10BaseT, 100BaseT4, 100BaseTx, 25 Mbps, ATM-51 Mbps, ATM-155 Mbps, ATM-2.4 Gbps, 1000 Base-TX and TP-PMD.
 2. Four individually twisted pairs.
 3. 23 AWG solid copper conductors.
 4. Horizontal cable performance shall meet or exceed requirements of ANSI/TIA/EIA-568-C.2-1 and ISO/IEC11801 Amendment 2.
 5. Category 6A cable shall be available in 4-pair F/UTP.
 - a. Have a Mylar tape surrounding the cable pairs with a drain wire with an aluminum foil tape surrounding the drain wire.
 6. Have a round cable jacket available in CMP options with a nominal cable O.D. of Category 6A cable shall not exceed .3 inch O.D. for plenum and .295 inch O.D. for riser.
 7. Category 6A copper cables shall be plenum type cable and listed for use in same.
 8. Cables shall have an exterior jacket available in the following colors:
 - a. White.
 - b. Yellow.
 - c. Black
 - d.
 9. At a minimum, the cable must be compliant to the following ratings and standards:
 - a. UL Standard: 444 UL Standard for Safety Communications Cables.
 - b. (UL) – C(UL) Type CMP or CMR/CMG (depending if cable is plenum or riser).
 - c. ANSI/NEMA WC 66/ICEA S-116-732-2013.
 - d. NEC 800 Type CMP or CMR/CM (depending if cable is plenum or riser).
 - e. ISO/IEC 11801:2010 (Ed. 2.2) - Edition 2, Amendment 2 Class EA horizontal cable requirements.
 - f. TIA-568-C.2-1 (July 2016) - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 10. Have a construction comprised of 4-pairs of 23AWG solid bare copper conductors utilizing a center isolation member to maintain pair geometry for optimal NEXT performance. Cables shall incorporate an oblique elliptical offset filler to minimize alien crosstalk.

11. Cables shall be manufactured with lead free materials.
12. Have a rip cord installed under the jacket for jacket removal.
13. Cable shall be capable of allowing excess of PoE plus standard wattage without degrading the cable up to 50 watts and/or 60 degrees C.
14. Category 6A cable shall meet the following electrical characteristics:
 - a. Conductor DC Resistance Maximum: 9.38Ω/1000feet
 - b. DC Resistance Unbalanced Maximum: 2 percent
 - c. Mutual Capacitance Maximum: 5.6pF/foot
 - d. Operating Temperature Maximum: -20° C to 75° C (-4° F to 167° F)
 - e. Operating Voltage Maximum: 300 VDC
 - f. Worst Case Cable Skew: 40nS/100M @ 100MHz for both Plenum and Riser
 - g. Nominal Velocity of Propagation: 69 percent @ 100MHz – Plenum
65 percent @ 100MHz - Riser
15. Meet the following electrical specifications:

Capacitance Unbalanced	<330 pF/100m
Characteristic Impedance (ohms)	1 ≤ f ≤ 100: 100 ± 15% 100 ≤ f ≤ 750: 100 ± 22%
LCL	30-10Log(f/100)dB

16. Category 6A 4-pair Plenum copper cables shall meet the following performance specifications:

FREQ (MHz)	FITTED IMPEDANCE (Ohms)	INSERTION LOSS (Db/100M)		RETURN LOSS (dB/100m)		Pair-Pair NEXT (dB/100m)		PSNEXT (dB/100m)	
	SPEC	MAX	TIA SPEC	MIN	TIA SPEC	MIN	TIA SPEC	MIN	TIA SPEC
1	100 ± 5	1.7	2.0	26.5	20.0	88.4	74.3	87.2	72.3
4	100 ± 3	3.4	3.7	31.1	23.0	82.8	65.3	80.0	63.3
8	100 ± 3	4.9	5.2	37.2	24.5	73.5	60.8	72.1	58.8
10	100 ± 3	5.5	5.9	30.3	25.0	73.9	59.3	71.7	57.3
16	100 ± 3	7.0	7.4	32.0	25.0	67.5	56.2	66.4	54.2
20	100 ± 3	7.8	8.3	35.2	25.0	70.0	54.8	68.5	52.8
25	100 ± 3	8.8	9.3	35.4	24.3	68.1	53.3	67.7	51.3
31.25	100 ± 3	9.9	10.4	38.9	23.6	67.4	51.9	64.7	49.9
62.5	100 ± 3	14.1	14.9	33.6	21.5	60.3	47.4	59.6	45.4
100	100 ± 3	18.0	19.0	28.1	20.1	59.2	44.3	57.8	42.3
155	100 ± 3	22.6	24.0	28.4	18.8	50.6	41.4	50.0	39.4
200	100 ± 3	25.8	27.5	27.3	18.0	52.5	39.8	51.4	37.8

FREQ (MHz)	FITTED IMPEDANCE (Ohms)	INSERTION LOSS (Db/100M)		RETURN LOSS (dB/100m)		Pair-Pair NEXT (dB/100m)		PSNEXT (dB/100m)	
	SPEC	MAX	TIA SPEC	MIN	TIA SPEC	MIN	TIA SPEC	MIN	TIA SPEC
250	100 ± 3	29.0	31.0	27.2	17.3	50.9	38.3	49.8	36.3
300	100 ± 3	31.8	34.2	25.0	16.8	46.9	37.1	46.4	35.1
350	100 ± 3	34.5	37.2	23.5	16.3	43.8	36.1	43.3	34.1
400	100 ± 3	37.0	40.0	24.5	15.9	47.2	35.3	44.7	33.3
450	100 ± 3	39.4	42.7	22.9	15.5	45.9	34.5	42.8	32.5
500	100 ± 3	42.8	45.3	17.7	15.2	47	33.8	43.9	31.8
550	100 ± 3	43.8		21.4		46.2		44.6	
600	100 ± 3	45.9		21.2		44.2		43.0	

17. Provide the following 4-connector guaranteed channel performance:

Frequency (MHz)	Insertion Loss (dB/328 ft.)	NEXT Loss (dB)	PS NEXT Loss (dB)	ACR (dB)	PSACR (dB)	ACR-F (dB)	PS ACR-F (dB)	Return Loss (dB)	Propagation Delay (ns)
1.0	2.0	74.3	72.3	72.3	70.3	67.8	64.8	20.0	570.0
4.0	3.8	65.3	63.3	61.5	59.5	55.8	52.8	23.0	552.0
10.0	6.0	59.3	57.3	53.3	51.3	47.8	44.8	25.0	545.0
16.0	7.6	56.2	54.2	48.7	46.7	43.7	40.7	25.0	543.0
20.0	8.5	54.8	52.8	46.3	44.3	41.8	38.8	25.0	542.0
31.25	10.7	51.9	49.9	41.2	39.2	37.9	34.9	23.6	540.0
62.5	15.4	47.4	45.4	32.0	30.0	31.9	28.9	21.5	539.0
100.0	19.8	44.3	42.3	24.5	22.5	27.8	24.8	20.1	538.0
200.0	29.0	39.8	37.8	10.8	8.8	21.8	18.8	18.0	537.0
250.0	32.8	38.3	36.3	5.5	3.5	19.8	16.8	17.3	536.0
300.0	36.4	37.1	35.1	0.7	-1.3	18.3	15.3	16.8	536.0
400.0	43.0	35.3	33.3	-7.7	-9.7	15.8	12.8	15.9	536.0
500.0	48.9	33.8	31.8	-15.1	-17.1	13.8	10.8	15.2	536.0

Frequency (MHz)	Insertion Loss (dB/328 ft.)	NEXT Loss (dB)	PS NEXT Loss (dB)	ACR (dB)	PSACR (dB)	ACR-F (dB)	PS ACR-F (dB)	Return Loss (dB)	Propagation Delay (ns)
550.0*	51.8	33.2	31.2	-18.6	-20.6	13.0	10.0	14.9	536.0
625.0*	55.8	32.4	30.4	-23.5	-25.5	11.9	8.9	14.5	535.0
750.0*	62.3	31.2	29.2	-31.1	-33.1	10.3	7.3	14.0	535.0

18. 4-Pair Riser copper cables shall meet the following performance specifications:

FREQ (MHz)	FITTED IMPEDANCE (Ohms)	INSERTION LOSS (Db/100M)		RETURN LOSS (dB/100m)		Pair-Pair NEXT (dB/100m)		PSNEXT (dB/100m)	
	SPEC	MAX	TIA SPEC	MIN	TIA SPEC	MIN	TIA SPEC	MIN	TIA SPEC
1	100 ± 5	1.6	2.0	25.3	20.0	86.7	74.3	85.5	72.3
4	100 ± 3	3.3	3.7	29.1	23.0	76.0	65.3	74.4	63.3
8	100 ± 3	4.7	5.2	30.1	24.5	73.8	60.8	71.7	58.8
10	100 ± 3	5.2	5.9	31.3	25.0	69.0	59.3	68.4	57.3
16	100 ± 3	6.7	7.4	31.4	25.0	64.9	56.2	63.9	54.2
20	100 ± 3	7.5	8.3	31.6	25.0	65.6	54.8	64.8	52.8
25	100 ± 3	8.5	9.3	31.2	24.3	60.5	53.3	59.8	51.3
31.25	100 ± 3	9.5	10.4	31.6	23.6	61.2	51.9	60.7	49.9
62.5	100 ± 3	13.6	14.9	35.5	21.5	58.0	47.4	56.9	45.4
100	100 ± 3	17.5	19.0	32.4	20.1	53.3	44.3	53.2	42.3
155	100 ± 3	22.2	24.0	29.6	18.8	55.7	41.4	54.4	39.4
200	100 ± 3	25.6	27.5	31.3	18.0	49.0	39.8	47.9	37.8
250	100 ± 3	28.9	31.0	27.6	17.3	44.0	38.3	43.8	36.3
300	100 ± 3	32.1	34.2	28.0	16.8	45.5	37.1	45.3	35.1
350	100 ± 3	35.0	37.2	26.4	16.3	44.4	36.1	44.3	34.1
400	100 ± 3	37.8	40.0	25.2	15.9	42.8	35.3	42.6	33.3
450	100 ± 3	40.4	42.7	24.9	15.5	39.4	34.5	39.2	32.5
500	100 ± 3	43.0	45.3	22.3	15.2	43.3	33.8	41.5	31.8
550	100 ± 3	45.5		25.2		42.0		41.1	

FREQ (MHz)	FITTED IMPEDANCE (Ohms)	INSERTION LOSS (Db/100M)		RETURN LOSS (dB/100m)		Pair-Pair NEXT (dB/100m)		PSNEXT (dB/100m)	
	SPEC	MAX	TIA SPEC	MIN	TIA SPEC	MIN	TIA SPEC	MIN	TIA SPEC
600	100 ± 3	47.9		21.3		42.0		39.7	

19. Category 6A:

a. Acceptable Cable Manufacturers:

1) General Cable 7151852

C. Exterior Grade Horizontal Copper Cabling:

1. Meet requirements for Category 6A requirements above.
2. Listed for outdoor use.
3. Manufacturer:
 - a. General Cable 8136100

2.3 -PATCH PANELS

A. Provide [Category 6]modular patch panels for the termination of all field data outlets at horizontal cross-connects in telecommunications rooms throughout the facility.

1. Patch panels shall be capable of terminating 48-ports.
2. 19 inch rack-mountable unit.
3. Unit shall be manufactured from cold-rolled steel for durability.
4. Termination jacks shall be 8-position, 8-conductor, non-keyed, RJ-45, T568 universal with 110 style IDC termination blocks.
5. 110 style IDC termination blocks shall be capable of terminating 22 AWG – 24 AWG solid copper conductors.
6. Panels shall have facilities for labeling each port.
7. Supply multiple 48-port patch panels as required for all terminations. 24-, 72-, 96-port, etc. patch panels will not be accepted.
8. Standard density; 3.5 inches H (2 RMUs) .
9. Manufacturers:

a. Category 6A:

1) Panduit DP246X88TGY (24-ports),

B. Fiber Optic Patch panels for the termination of the fiber optic cabling at telecommunications rooms throughout the facility.

1. Rack Mountable Enclosure:
 - a. Standard 19 inch width.
 - b. Capable of terminating a minimum of 24-ports utilizing 4, 6-port standard density, adapter plates.
 - c. Label inserts to identify cabling.
 - d. Fully enclosed tray for coiling fiber and clear plastic front panel to protect coupled connectors inside front panel.
 - e. Cable strain relief brackets for support.
 - f. Provide an engraved, laminated plastic plate on the fiber patch panel cover to read "Warning, Fiber Optic Cables Enclosed."
 - g. Dust covers shall be provided and installed at all terminations upon completion of terminations.

- h. Patch panel color shall be black.
 - i. Optional splice housing adapter where required.
 - j. Manufacturers:
 - 1) Corning CCH-01U 1RU at each Telecom Room
 - 2) Corning CCH-03U 3RU for the MDF
- 2. Adapter Plates/Bulkheads:
 - a. Provide 12-port, standard density adapter plates as required to mount all fiber terminations.
 - 1) LC Adapters:
 - a) Multimode adapter plate for termination of six (6) 2-strand connectors, Corning 95-000-04 fiber termination unit.
- 3. Terminations:
 - a. LC Terminations:
 - 1) Ceramic Ferrule, 50/125 um, multimode.
 - 2) Ceramic Ferrule, single mode.
 - b. Manufacturers:
 - 1) Corning Cable Systems, or equal to match fiber termination unit.
- 4. Pigtails:
 - a. Factory terminated, LC terminations.
 - b. Fusion splice only for connection to cabling system.
- 5. Buffer Tube Fan-Out Kits:
 - a. Minimum 25 inch buffer tubing.
 - b. Color coded buffer tubes.
 - c. Specifically designed for indoor/outdoor or outdoor fiber optic cabling.
 - d. Manufacturer: Corning Cable Systems #FAN-OD25-12 or approved equal.

2.4 MODULAR TELECOMMUNICATIONS OUTLETS

A. Faceplates:

- 1. All telecommunications outlets shall have a flush (low-profile assembly), nylon (high-abuse), tamper-resistant faceplate as required to mount to the field outlet backbox. Provide all mounting hardware.
 - a. Provide jack identification icons.
 - 1) Color and symbol to be defined at project equipment submission.
 - b. Device shall be tamperproof. Data jacks shall require faceplate removal for access.
 - c. Mounting: Screws shall be tamperproof type. Screw head color shall match faceplate.
- 2. Single gang faceplates shall have 2-, 4-, or 6-port connector openings as required.
 - a. Faceplate shall accommodate two (2) recessed label locations with protective clear plastic covers.
 - b. Provide approved interchangeable icons/service descriptions identifying each jack.
 - c. Provide blank port inserts to match faceplate if port is not required for termination.

3. Double gang faceplates shall have 4-, 6-, or 12-port connector openings as required.
 - a. Faceplate shall accommodate four (4) recessed label locations with protective clear plastic covers.
 - b. Provide approved interchangeable icons/service descriptions identifying each jack.
 - c. Provide blank port inserts to match faceplate if port is not required for termination.
 4. Modular 3-Port and 4-Port Furniture Faceplate:
 - a. Flush mounted 3- or 4-port plate as shown on Drawings.
 - b. Label location with cable plastic covers and icon identifier.
 - c. Sized for specified furniture opening.
 - d. Color to match furniture mounted on.
 5. Modular Faceplate for Poke-Thru/Doghouse Devices:
 - a. Flush mounted device plate to fit device opening.
 - b. Coordinate with Division 26 for manufacturer type to match component system.
 6. Faceplate color as selected by the Architect/Engineer. Available colors shall be:
 - a. White.
- B. Termination Jacks:
1. Category 6A Shielded Jacks:
 - a. 110 Style IDC PC board block. Modular jacks shall utilize a secondary PC board separate from the signal path for crosstalk compensation.
 - b. T568A or T568B (Universal).
 - c. 8-position, 8-conductor, RJ-45, non-keyed.
 - d. Must support a minimum of 200 reterminations.
 - e. Capable of terminating 22 AWG - 24 AWG solid or 24 AWG stranded conductors.
 - f. Utilizes technology with optimized pair balance design and linear crosstalk response to address applications up to 500 MHz.
 - g. Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
 - h. Electrical Requirements – to PoE demands to 600mA.
 - 1) Min. Dielectric Withstand Voltage (Contact to Contact): 1000VA RMS.
 - 2) Min. Dielectric Withstand Voltage (to Conductive Surface): 1500VAC RMS.
 - i. Verify color of termination jack prior to installation.
 - 1) Jack color shall match color of faceplate.
 - 2) Jacks shall be available in the following colors:
 - a) Yellow.
 - 3) Shielded jacks may use colored icons for identification.
 - j. Manufacturers:
 - 1) Panduit CJ6X88TGYL
 2. Fiber Optic Termination Jacks:
 - a. Multimode, 50/125 micrometer:
 - 1) LC Type:
 - a) Meet intermateability requirements of EIA/TIA-604-12.

3. Dust Caps:
 - a. Removable plug caps protect unused jacks from outside contaminants.
 - b. Provide a dust cap for each copper and fiber terminated jack at work area outlets.

C. Direct Attach Field Terminable Male Plug:

1. Category 6A shielded field installable male plug.
2. ANSI/TIA-568-C.2 Category 6A.
3. IEC 60603-7-41.
4. Supports IEEE 802.3an 10GBASE-T.
5. Supports IEEE 802.3at POE+.
6. Accommodates 22 AWG - 24 AWG solid copper conductors.
7. 1000 VDC dielectric withstand.
8. Current Rating: (50°C) - 1A.
9. Temperature Range: -40°C - 70°C.
10. UL 1863.
11. Manufacturers:
 - a. Corning;

D. Direct Attach Field Terminable Male Plug:

1. Category 6 field installable male plug.
2. ANSI/TIA-568-C.2 Category 6A.
3. IEC 60603-7-41.
4. Supports IEEE 802.3at POE+.
5. Accommodates 22 AWG - 24 AWG solid copper conductors.
6. 1000 VDC dielectric withstand.
7. Current Rating: (50°C) - 1A.
8. Temperature Range: -40°C - 70°C.
9. UL 1863.
10. Manufacturers:
 - a. Panduit FP6X88MTG **Category 6OCC**; #OCCUFP6.

2.5 TRANSITION CABLE ASSEMBLY

- A. Pre-manufactured cable assembly to connect and terminate an RJ-45 jack in a multi-service box to a desk mounted RJ-45 female termination jack:
 1. Pre-terminated RJ-45 plug (male connector) on one end to be connected in multi-service box.
 2. Length to allow installation cable from multi-service box to table box (via table leg or otherwise concealed).
 3. Field terminated RJ-45 jack (female connector) mounted in face plate or at cable retractor unit at user work area (table box).
 4. Solid conductor twisted pair cabling.
 5. Cabling type to match installed category/shielding as indicated to terminating multi-service box.
- B. Manufacturer to match cable and/or connectivity solution.

2.6 PATCH CORDS – Confirm with owner if patch cords from outlet to end-user devices is required.

- A. For each data jack installed, provide 1' Yellow Cat 6A patch cords to connect from the patch panel to the switch. -Fiber optic patch cords for use at the patch panels and work area outlets. Factory manufactured and tested.

1. 50/125 Micrometer Patch Cords OM3
 - a. LC type, multimode, duplex, 2-meter, aqua.
 - 1) Quantity of **12**.
2. Manufacturers:

Belden/CDT.

- a. Corning Cable Systems.

2.7 CROSS-CONNECT WIRE

- A. Category 6 Compatible Solution:
1. 24 AWG, 4-pair insulated solid copper wire.
 2. Manufacturers:
 - a. Belden/CDT; Giga BIX Series.
 - b. Siemon; CJ6-W4-1000 Series.

2.8 LABELING

- A. Machine Printed Labels:
1. Self-adhesive, smudge resistant vinyl labels for cables and faceplates.
 2. Size labels appropriately for cable diameter; utilize "wrap" installation.
 3. Size labels appropriately to fit in recessed area of faceplate or under available plastic cover.
 4. Size labels appropriately to fit on punch-down block and patch panel labeling location.
 5. Submit samples of labels to verify color of label and size of font for each application.
 6. Center justify all text.
 7. Utilize Hellermon-Tyton Spirit 2100 or approved equal by Rhino Pro, Brother, or Panduit.
- B. Engraved, Laminated Acrylic, or Melamine Label:
1. White letters on a dark-gray background.
 2. Minimum letter height shall be 3/8 inch (10 mm).
 3. Punched or drilled for screw mounting.

2.9 CABLE INFRASTRUCTURE SUPPORT

- A. J-Hook:
1. Metallic J-hook bracket (1-1/2 inches wide) with cable retainer or Velcro strap, capable of being ceiling or support rod mounted.
 - a. Provide manufacturer recommended fasteners as required.
 2. Category 6 compliant.
 3. Acceptable Manufacturers/Series:
 - a. Caddy Cat. HP932 Series.
 - b. B-Line BCH32 Series.
 - c. Or approved equivalent.

B. Cable Tie:

1. Reusable hook and loop cable managers (Velcro).
2. 1/2 inch width minimum by length as required with oversized head, slot, and mounting hole.
3. Color to match cabling/system.
4. Manufacturer: Siemon Part #VCM-100-XXX-X or approved equal by Panduit.

C. Equipment Backboards:

1. 3/4 inch AC Plywood:
 - a. Minimum 4 foot W by 8 foot H by 3/4 inch sheets, of quantity as specified or shown.
 - b. Void free, mounted to support attached equipment.
2. Cable Distribution Spools:
 - a. Fire-retardant, high strength composite material.
 - b. 1-1/2 inch length.
 - c. Promotes compliance with T568B bend radius (4x cable diameter).
3. Grounding Provision:
 - a. Provide copper grounding bar to match panelboards.

D. Pull Line:

1. Minimum 210 pound tensile strength continuous-fiber polypropylene polyline line for installation directly into conduit.
2. White with green or gray tracer for easy identification.
3. Waterproof line can be left in conduit for future use. Will not rot or mildew.
4. Manufacturer:
 - a. Ideal 31-338.
 - b. Approved equal.

E. Pull Tape:

1. Durable and stretch resistant tape for easily pulling and installing copper and fiber optic cables.
2. Factory lubricated to reduce burn-through in innerduct.
3. Imprinted with sequential footage or meter markings for accurate measurements.
4. Minimum Average Breaking Strength: 1,800 lbs. (8.01 kN).
5. Manufacturers:
 - a. Greenlee 4436.
 - b. Ideal 31-315.
 - c. Approved equal.

2.10 NETWORK DOCUMENTATION AND CABLE MANAGEMENT SOFTWARE

A. Provide a software based network documentation/cable management package to be utilized for moves, adds, and changes for cable administration.

1. Web-based Software Application.
2. Password/Log-In Security.
3. Documentation Help Wizard.
4. Spreadsheet Import Tool – Coordinate and Implement with Labeling Software Solution.
5. Test Results Import Tool – Coordinate and Implement with Testing Software Solution.
6. Customized Fields.

7. ANSI/TIA/EIA 606A Compliant.
8. Manufacturer: Brady Net Doc or approved equal.

END OF SECTION 271000

SECTION 271116 - COMMUNICATIONS CABINETS AND RACKS

PART 1 - PRODUCTS

1.1 DATA TERMINATION CABINETS AND RACKS

- A. General: Provide data racks, cabinets, etc. as shown on Drawings to meet the requirements of the surrounding environment.
- B. Comply with NEBS GR-63-Core requirements.
- C. Open Frame Data Equipment Racks:
 - 1. 19 Inch Free Standing Two Post Equipment Racks:
 - a. 19 inch double sided equipment rack with universal (EIA) threaded mounting holes – 5/8 inch, 5/8 inch - 1/2 inch) on front and rear.
 - b. 84 inch height, 19 inch width.
 - c. Uprights shall be **6** inch width.
 - d. Minimum, 45 rack mount units.
 - e. Universal numerical identifiers on rack rails.
 - f. Include support rods, brackets, and pre-drilled holes for connecting/supporting ladder rack.
 - g. ANSI/EIA 310-D compliant.
 - h. Color shall be black.
 - i. One double-sided vented shelf.
 - j. Manufacturers:
 - 1) Chatsworth Products, Inc. [**#3" Wide 55053-xxx.**] [**#6" Wide 66353-X03 OSHPD 48353-715.**] [**Seismic® 13855-x03.**]
 - 2) Cooper/B-Line.
 - 3) Belden/CDT.
 - 4) Great Lakes Case & Cabinet.
 - 5) Hubbell Premise Wiring.
 - 6) Ortronics.
 - 7) Panduit.
 - 8) Approved equal.
- D. Wall Mounted Open Frame Data Equipment Racks:
 - 1. 19 inch, standard wall mount rack with swing capability for termination access.
 - 2. 19 inch width, 18 inch depth, 35 inch height (18 rack mount units).
 - 3. Swing gate opens 180 degrees; dual (upper and lower) locking latches.
 - 4. Stackable[; **provide 2 vertically stacked units for 18 RMU of space**].
 - 5. Universal 5/8 inch – 5/8 inch – 1/2 inch alternating hole pattern drilled on both front and back sides with Universal numerical identifiers. Standard mounting screws without mounting clips.
 - 6. 150 lbs. load capability.
 - 7. Color shall be black[.].
 - 8. Manufacturers:
 - a. Chatsworth Products Inc. [**#11348-719.**]
 - b. Approved equal.

1.2 CABLE MANAGEMENT EQUIPMENT

- A. Horizontal Wire Management Enclosures for All Racks and Cabinets:
 - 1. 19 inch rack mounted.

2. Slotted, plastic duct with snap-on plastic covers.
3. CAT6A cable capacity equal to or greater than total number of patch panel ports using 40 percent fill rate.
4. Provide horizontal wire management front and rear.
5. Two (2) rack mounting units.
6. Quantity: Mount one (1) above the top copper patch panel and provide one (1) additional unit for each patch panel.
7. Manufacturers:
 - a. Panduit.
 - b.

B. Horizontal Cable Support Bracket (Rack Mounted):

1. 19 inch rack mounted.
2. Metal support bar, 5 inches deep, mounts to rear of data rack for cabling support.
3. Quantity: Provide one (1) unit for each patch panel.
4. Manufacturers:
 - a. AMP #557548-1 or approved equal.

C. Vertical Wire Management Enclosures for All Racks:

1. Rack mounted[**designed by manufacturer to attach to racks with 6 inch deep uprights**].
2. Mounted to support entire length of rack.
3. Front and rear aluminum accessible door assemblies.
4. Rigid cable manager with 1U spaced cable guides.
5. Rear and front mounted (double sided) cable management capability designed for Category 6A and fiber installations based upon a fill rate of 35 percent to accommodate proper cable routing techniques.
6. Quantity:
 - a. Provide two (2) units the length of rack for each open frame data rack.
 - b. Provide one (1) unit only between side by side mounted racks.
7. Size:
 - a. **[6] [8] [10] [12]** inch width by 24.5 inch depth.
 - b. **[3.6] [6]** inch width by 16.4 inch depth.
8. Manufacturers:
 - a. Chatsworth Products, Inc. **[Evolution] [Velocity] [CCS]** Series.
 - b. Panduit.
 - c. Belden/CDT.
 - d. B-Line/Cooper.
 - e. Panduit.
 - f. Approved equal.

1.3 CABINET AND RACK ACCESSORIES

A. Uninterruptible Power Supply:

1. 1600 watt on-line power supply.
2. Internal battery set offers 14 min. runtime at half load (800W) and 4.5 min. at full load (1600W).
3. Provide[**2 post**] rack mounting hardware kit.
4. Auto shutdown, network communication software.

5. RJ45 network interface 10/100 Mbps auto-sensing allows LAN communication compatibility with 10/100 Base-T network.
 6. HID-compliant USB interface with built-in power management and auto shutdown features for Windows and Mac OS X. Monitoring of equipment load levels, self-test data, and utility power conditions.
 7. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - a. Tripp Lite Power Protection SU2200RTXL2UA / 2POSTRMKITWM and SNMPWEBCARD (Basis-of-Design).
 - b. American Power Conversion, APC, by Schneider Electric.
 - c. Liebert, division of Emerson Network Power.
- B. Power Strip – Horizontal:
1. 8 transformer spaced 3-prong 110 outlets.
 2. 330/500 clamping voltage.
 3. 15 amp, 125VAC.
 4. On/Off switch.
 5. Green LED power on, Red LED surge protection active.
 6. 19 inch rack horizontal mounted unit.
 7. Uses one (1) standard rack unit.
 8. Manufacturers:
 - a. Chatsworth Products, Inc. #12301-719.
 - b. Geist.
 - c. Middle Atlantic.
- C. Power Distribution Unit – Horizontal - 120 Volt:
1. 8 transformer spaced 3-prong 110 outlets.
 2. 330/500 clamping voltage.
 3. 15 amp, 125VAC.
 4. On/Off switch.
 5. Green LED power on, Red LED surge protection active.
 6. Power monitor, with amperage, voltage, wattage.
 7. Ethernet connectivity with IP-addressable module for software monitoring; setpoints and alarms via e-mail, application pop-ups.
 8. Temperature, humidity sensors, and alarm setpoints.
 9. 19 inch rack horizontal mounted unit.
 10. Uses one (1) standard rack unit.
 11. Manufacturers:
 - a. Chatsworth Products, Inc.
 - b. Geist.
 - c. Middle Atlantic.
- D. Power Distribution Unit – Horizontal – 220/240 Volt:
1. Sized to accommodate 2p. 40A connectivity for two power supplies from two sources. Two (2) units may be required.
 2. Ethernet connectivity with IP-addressable module for software monitoring; setpoints and alarms via e-mail, application pop-ups.
 3. Power monitor, with amperage, voltage, wattage.
 4. Temperature, humidity sensors, and alarm setpoints.
 5. 19 inch rack horizontal mounted unit.
 6. Manufacturers:
 - a. Chatsworth Products, Inc.

- b. Geist.
- c. Middle Atlantic.

1.4 CABINET AND RACK GROUNDING PROVISIONS

- A. Provide and install a complete telecommunications rack/cabinet grounding system including the following equipment for each rack or cabinet:
 - 1. Manufacturer:
 - a. Panduit® StructuredGround™.
 - b. Approved equal.
 - 2. Rack Grounding Strip:
 - a. 7 foot length, mounted to rack rail. (One for each post).
 - b. Part Number: RGS.
 - 3. Paint Piercing Grounding Washer Kit: Part Number RGW.
 - 4. Bonding Screws for All Equipment: Part Number RGTBS.
 - 5. Equipment Jumper Kits (total of 5 for each rack): Part Number RGEJ.
 - 6. Rack Mounting Lug: Part Number LCC6-14JAWH-L.
 - 7. Electrostatic Discharge Port Kit (include ESD wrists strap): Part Number RGEDS.
 - 8. Front to Back Rail Jumper Kit (for cabinets only): Part Number CGJ640U.
 - 9. Common Grounding Busbar (for cabinet only): Part Number RGCBNJ.

PART 2 - EXECUTION

2.1 INSTALLERS

- A. Provide experienced and qualified technicians to carry out installation of system equipment and programming.
- B. Provide cutting and patching necessary to perform work per appropriate sections.

2.2 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine areas and conditions under which work is to be performed. Confirm suitability of conditions for installation of products to avoid latent defects in quality of work and function.
 - 2. Verify that conditions are satisfactory for installation of system, cable, and components.
 - 3. Ensure components and conditions are in compliance with manufacturer's requirements, installation tolerances, and other conditions affecting performance.
- B. Pre-Installation Testing:
 - 1. Identify and document conditions detrimental to proper or timely completion.
- C. Evaluation and Assessment:
 - 1. Correct unsatisfactory conditions.
 - 2. Do not proceed until unsatisfactory conditions have been corrected.

2.3 INSTALLATION

- A. General:
 - 1. Install equipment in accordance with manufacturer's written instructions.
 - 2. Install all equipment to industry safety and ergonomic standards and provide full engineering and technical support throughout the installation process.

3. Provide cabinets, and associated raceway/pathway installations including special wire management auxiliaries.
 - a. In order to ensure that vertical and horizontal cord managers are capable of accommodating the anticipated maximum density of cords, they should both be included during fill calculations.
 - b. Selection of vertical cable managers shall take into account maximum calculated fill of 25 percent including cord service loops, thereby providing for available cross-sectional area up to double the anticipated calculated fill needs.
 - c. Vertical cord managers should extend from the floor to the top of the racks. The vertical cable managers shall be not less than 3.25 inches (83 mm) in width.
 - d. Horizontal cord managers should be installed to accommodate maximum calculated fill requirements and providing for a strategic growth factor of up to 100 percent. Cable management should be adequate to ensure that the cables can be neatly dressed and do not impair cooling, and that bend radius requirements are met.
4. Provide all labor, tools, materials, services and technical knowledge to provide a complete, reliable installation.
5. Install all in a safe, neat, professional, workmanlike manner.
- B. Assemble all cabinets and racks per riser diagrams and approved submittal layout drawings.
 1. Mount patch panels per Division 27 Section "Structured Telecommunications Cabling System."
 2. Install cabinet/rack grounding system.
- C. Locate data racks and cabinets as shown on Drawings and approved submittal layout drawings.
 1. Mount racks and cabinets a minimum of 3 feet-0 inches from back of rack to wall.
 2. Securely mount data racks and cabinets to the floor using minimum 3/8 inch hardware.
 3. Gang multiple racks with cable management units between racks.
 4. Install wall mounted cabinets 60 inches from the floor to top of unit. Refer to manufacturer's data for stacking cabinets.
- D. Coordinate locations of racks with telecom conduits, fire rated assemblies and sleeves entering telecom room.
- E. Coordinate location of racks with cable tray entrance and cable runway installation.
- F. Provide concealed conduit for cable entrance into cabinets installed in areas outside of telecommunications rooms and equipment rooms.
- G. Install data racks and cabinets a minimum of 20 feet from electrical distribution panels greater than 480 volts.
 1. Locate data racks and cabinets to maximize the distance from sources of EMI such as transformers, power panels, fluorescent lighting, etc.
- H. Label all data racks and cabinets at top of rack with facility, telecommunications room designation/number, and rack designation as shown on Drawings and approved by Engineer.
- I. Grounding:
 1. Tighten equipment grounding connections for system connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
 2. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, 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.

2.4 LABELING

- A. Label all data racks, cabinets, equipment, etc. within the telecommunications room.
- B. Refer to Division 26 Section "Electrical Identification."
- C. Refer to Division 27 Section "Communications Identification."

2.5 SIGNAL GROUNDING

- A. Bond all racks and cabinets to the Telecommunications Ground Busbar (TGB) within the telecommunications room.
 - 1. Install telecommunications rack and cabinet grounding system per manufacturer's guidelines at each data rack and cabinet.
 - 2. Multiple racks shall be bonded together with grounding bar kit.
 - 3. Remove rack finish at bond connection to ensure proper connection.
 - 4. Extend green ground wire from rack/cabinet ground to TGB with conductor sized per schedule.
- B. Coordinate signal grounding system with **[Division 26 Section "Grounding and Bonding"]** **[Division 27 Section "Grounding and Bonding of Communications Systems"]** for interconnection of equipment to grounding system.

2.6 UNINTERRUPTIBLE POWER SUPPLIES – POWER DISTRIBUTION UNITS

- A. Provide and install one (1) UPS at each data rack/cabinet in each telecommunications room.
- B. Provide and install one (1) 8-outlet, 120 volt, horizontal power distribution unit for each data rack provided and mount to each rack near UPS to accommodate network electronics power cords.
- C. Provide and install one (1) 220 volt power distribution unit for each telecommunications room to accommodate the Core Network Electronics equipment.

2.7 CLEANING

- A. Clean all equipment on a day-to-day basis and provide final cleaning of all communications equipment prior to turning building over to the Owner. Clean to the satisfaction of the Owner's representative.
- B. Provide cleaning consisting of vacuuming all panels, terminations, enclosures (inside and out), etc. If equipment is wet or contains moisture, it shall be thoroughly dried before testing.

2.8 CLOSEOUT ACTIVITIES

- A. Field Quality Control:
 - 1. Schedule review and sign off with the **[Owner]** **[Engineer]**.
 - a. Operation and Maintenance Data: Provide approved shop drawings with modifications as required by Engineer's instructions or project progression. Include operating and maintenance instructions, parts inventory listing, purchase source listing, emergency instructions and contact information, assembly/ disassembly and termination diagrams, and wire administration data as specified herein.
 - b. Provide any additional information as required per the manufacturer's requirements for required warranties.

B. Turnover Meeting:

1. Meeting:

- a. Upon completion of all work, coordinate and attend a meeting with the Owner and Owner's representative at the site to provide all as-built documentation, certifications, test reports, spare parts, tools, training DVD, and additional manuals, etc. This shall be done upon completion of final punch list and without requirement of final payment being processed.
- b. Provide in-depth review of all documentation and equipment to Owner for acceptance.

END OF SECTION 271116

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SECTION 271123 - CABLE RUNWAY

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Chatsworth Products, Inc.
 2. B-Line (Flex Tray) Systems, Inc.
 3. Wiremold/Legrand.

2.2 CABLE RUNWAYS, GENERAL REQUIREMENTS

- A. Cable runway systems shall be of indicated types, sizes, and NEMA classes and shall be complete with manufacturer's recommended covers, barrier strips, dropouts, fittings, conduit adaptors, hold-down devices, grommets, and blind ends as required and indicated.
- B. Cable runway products shall have rounded edges and smooth surfaces.

2.3 MATERIALS AND FINISHES

- A. Cable Runways, Fittings, and Accessories:
1. Tubular Steel – 2" x .375".
 2. 1/2" x 1" steel channel welded rungs.
 3. UL Classified as Equipment Grounding Conductor.
 4. Material: ASTM A513 Steel Tube.
 5. Finish: Flat black, powder coated.
- B. Cable Runways, Fittings, and Accessories:
1. Tubular Steel - 1-1/2" x .375".
 2. 1/2" x 1" steel channel welded rungs.
 3. UL Classified as Equipment Grounding Conductor.
 4. Material: ASTM A513 Steel Tube.
 5. Finish: Flat black, powder coated.

2.4 SIZES AND CONFIGURATIONS

- A. Ladder-Type Rail Spacing: .18 inches o.c.
1. Use 12 inch wide runway over data racks.
- B. Ladder-Type Runways Cross-Rung Spacing: 12 inches o.c.
- C. Ladder-Type Runways Nominal Side-Rail Height: 1-1/2 inches.

2.5 CABLE RUNWAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as required to provide routing shown and intended on drawings of same materials and finishes as cable runway.
- B. Cable runway supports and connectors as recommended by cable runway manufacturer.
- C. Conduit-to-Cable Runway Adaptors: U clamp type, of same materials and finishes as cable runways.

D. Cable Drop-Outs (Waterfalls):

1. Sized to cable runway width for cable bundle distribution.
2. Category 6 compliant (meeting minimum bend radius).
3. Match size, material, and finish as cable runway.

E. Runway Elevation Kit:

1. Supports runway above a continuous row of racks and/or cabinets.
2. Provides 6 inch minimum space over data racks for cable installation.
3. Mounts directly to racks/cabinets.
4. Match size, material, and finish as cable runway.

F. Cable End Caps:

1. Plastic end caps for installation over stringer rails.

G. Loop Cable Manager:

1. Runway mounted loop configuration to create data cabling service loop.
2. Finish to match cable runway.
3. Mounts above runway, directly above each data rack and cabinet.
4. Quantity to match number of data racks and cabinets in each telecommunications room.
5. Manufacturer: Snake Loop Manager SN-LP-1 or approved equal.

H. Manufacturer:

1. Chatsworth # 10250-718 – 18" Wide and a rung spacing of 12"
2. Chatsworth # 11421-718 – Wall Angle Support Kit
3. Chatsworth # 11312-718 – Triangular Support Bracket Aluminum
4. Chatsworth # 12730-718 – 3" channel Rack-To-Runway mounting Plate with Bracket
5. Chatsworth # 12731-718 – 6" channel Rack-To-Runway mounting Plate with Bracket
6. Chatsworth # 11310-793 – Threaded Ceiling Kit, Cable Runway
7. Chatsworth #11310-794 – Threaded Ceiling Kit, Cable Runway

2.6 GROUNDING AND BONDING

A. Bonding Jumper Kit: Fittings and bolted connectors to provide bond between sections of cable runway, or cable runway and raceway or equipment ensuring electrically continuous pathway to ground for eddy currents and faults.

1. Round insulated stranded copper conductor minimum #6 AWG.
2. Length shall be less than 16 inches.
3. Two hole compression lugs with 1/4 inch bolt holes spaced 5/8 inch on center on both ends.
4. 1/4-20 bolts, flat washers, lock washers, 1/4 inch nuts.
5. 1/2 ounce antioxidant compound.
6. Manufacturer: Harger 67G1222A1/4KIT or approved equal.

2.7 SUPPORTS AND CONNECTORS

1. Cable runway supports and connectors shall be as recommended by cable runway manufacturer and per Division 26 Section "Hangers and Supports."
2. Universal Earthquake Bracing Kit: Provide above data racks for additional support for top of rack.
3. Manufacturer: Chatsworth Products #10562-001.

2.8 FASTENERS FOR SUPPORTS

- A. Fasteners to connect cable runway supports to the building structure shall be as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.

2.9 FIRESTOPPING

- A. General: Materials shall be UL listed and labeled and FM approved for fire and smoke ratings consistent with penetrated barriers, per Division 07 and Division 26 Section "Sleeves and Fire-Rated Assemblies":
 - 1. Utilize complete fire rated assembly around runway in conjunction with solid bottom runway and cover at fire and smoke wall penetrations per Division 26 Section "Sleeves and Fire-Rated Assemblies."

2.10 WARNING SIGNS

- A. Lettering: 1-1/2-inch high, black on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- B. Materials and Fastening: Conform to Division 26 Section "Electrical Identification."

2.11 SOURCE QUALITY CONTROL

- A. Perform design and production tests according to NEMA VE 1.

PART 3 - EXECUTION

END OF SECTION 271123

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SECTION 274111 - INTEGRATED AUDIO VISUAL SYSTEMS FOR CONFERENCE ROOMS

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 PERFORMANCE

- A. General: The following minimum performance standards shall be met by the audio visual system.
- B. Audio:
 - 1. Signal/Noise ratio (including crosstalk and hum): 75 dB minimum.
 - 2. Total Harmonic Distortion: 0.5 percent maximum from 30 Hz to 15,000 Hz.
 - 3. Frequency Response: Flat within +1.0 dB, 30 Hz to 15,000 Hz.
 - 4. The spatial level uniformity criterion, throughout the coverage area of the system, is that amplified sound levels shall not vary more than +/-4 dB as measure using a test signal consisting of an octave band of "pink" noise centered at 4,000 Hz.
 - 5. Measurements of system performance will be made using a calibrated ANSI or IEC precision sound level meter set for "slow" meter damping and flat response, 4 feet above the floor (seated ear height) within the system coverage area. All interior finishes and furnishing shall be in place, and system gain shall be adjusted to provide levels of at least 70 dB or 10 dB above background noise levels, whichever is higher, at the measuring locations for these tests.
 - 6. To meet the acoustical performance criteria, be responsible for setting the initial adjustments of loudspeakers, equalizers and other signal-processing equipment, pads, and gain controls and, under the direction of the Owner's authorized representative, during demonstration and acceptance testing, making the final adjustment of these items.
 - 7. Adjust all equalizers to realize maximum gain and optimal tonal balance from the sound system throughout the audience area.
 - 8. Output level of all program sources arriving at switching or routing equipment shall be within +/-25 dB of each other as measured at the input to the switcher or router. Provide pads, line amplifiers, or other gain control devices as required to achieve this specification.
- C. Video:
 - 1. Provide digital signal integrity of 1080P/60 Hz and 8 bit color throughout system.
 - 2. Digital Bit Error Rate: Zero.
 - 3. Digital Signal Data Rate: 4.64 Gbps.
 - 4. Signal/Noise Ratio (peak to RMS), Unweighted DC to 4.2 MHz: 45 dB minimum.
 - 5. Crosstalk, Unweighted DC to 4.2 MHz: 45 dB minimum.
 - 6. Frequency Response (RGBHV): Within +0.5 dB to 300 MHz.
 - 7. Frequency Response (composite): Within +0.5 dB to 10 MHz.
 - 8. Frequency Response (component): Within +0.5 dB to 100 MHz.
 - 9. Line and Field Tilt: 2 percent maximum.
 - 10. Differential Gain: 3 percent maximum.
 - 11. Differential Phase: 2 degrees maximum.
- D. Test Signal Paths:
 - 1. Audio: From any and all source inputs (microphones, audiotape units, videotape units, etc.) through all audio mixers, switchers, distribution amplifiers, codecs, etc., to all signal designations.
 - 2. Video: From any and all source inputs (microphones, audiotape units, videotape units, etc.) through all video mixers, switchers, distribution amplifiers, codecs, etc., to all signal destinations.

3. Prior to ordering equipment, coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.
4. Video: Recover digital video signals including re-clocker for display port, SDI and HD-SDI and regeneration for DVI and HDMI.
 - a. Utilize digital tester. Manufacturer: Quantum Data 780.

2.2 MANUFACTURERS

- A. Careful attention has been made to specify current production models for all equipment listed; however, due to frequent updates of equipment in this field some model numbers may become discontinued. Equipment with the same features and functionality shall be provided as a replacement as recommended by the manufacturer at the time this project is built. In such cases, the nearest equivalent product by the same manufacturer of the discontinued product shall be provided.
- B. AV systems and associated related equipment shall be furnished by a single supplier. Coordinate the features of materials and equipment so they form an integrated system with components and interconnections matched for optimum performance of specified functions in the specific rooms.
- C. Manufacturers: Subject to compliance with requirements, provide products and components as follows:
 1. Epson
 2. Da-Lite
 3. Chief
 4. Cisco Board
 5. NewLine
 6. Extron.
- D. Basis of Design is Two-way speakers with ExtronSignal Processing for a complete operating system. Equal manufacturers listed must achieve the same or better uniform performance as a system.
 1. System performance requirements are as following in seating areas:
 - a. Frequency Range: 1000 Hz – 4000 Hz.
 - 1) Average SPL = 104 dB.
 - 2) Minimum SPL = 99 dB.
 - 3) Maximum SPL = 108 dB.
 - b. Frequency Range: 4000 Hz – 8000 Hz.
 - 1) Average SPL = 102 dB.
 - 2) Minimum SPL = 93 dB.
 - 3) Maximum SPL = 107 dB.
 - c. Frequency Range: 500 Hz to 1000 Hz.
 - 1) Average SPL = 106 dB.
 - 2) Minimum SPL = 102 dB.
 - 3) Maximum SPL = 113 dB.

2. Provide manufacturer documentation including ease sound model with coverage maps identifying system meets requirements.
 - a. Selecting system other than Basis of Design Contractor is responsible for verifying speaker locations and mounting requirements.
- E. Video Components:
 1. Presentation Switcher:
 - a. Video Inputs:
 - b. 1 DisplayPort
 - c. 5 HDMI/DVI.
 - 1) 1 HDMI/DVI loop-out, configurable (non-scaled, with CEC)
 - 2) 2 DTP2/XTP-configurable
 - d. Video Outputs:
 - 1) 1 HDMI/DVI (with CEC) .
 - 2) 1 DTP2/XTP/HDBT, configurable (with CEC)
 - e. Audio Inputs:
 - 1) 2 stereo line level, balanced or unbalanced
 - 2) 2 mono mic/line level, balanced or unbalanced, (with available phantom power)
 - 3) 6 stereo, (de-embedded HDMI-PCM only, or remote unbalanced analog*)
 - f. Line inputs: +4 dBu (1.23 Vrms), -10 dBV (316mVrms), adjustable
 - g. Mic/line inputs: -60 dBV, +4 dBu, -10 dBV, adjustable
 - h. 70 dB @ 1kHz
 - i. 2 RMU rack mount.
 - j. Power supply.
 - k. Manufacturer: Extron IN1808 IPCP Q
 2. Ultra-Short Throw:
 - a. Wall mounted with the following features:
 - 1) Brightness: 5000 ANSI Lumens (Color and White) .
 - 2) Resolution: 1080p (1366 x 768 x 2).
 - 3) Contrast Ratio: 2,500,000:1.
 - 4) Size – projected distance: (16:9) 65" - 100"
 - 5) Keystone Correction: Horizontal +/- 3 degrees, Vertical +/- 3 degrees
 - 6) Focal Length: Provide lens to meet screen size listed for projector.
 - 7) Digital zoom and focus.
 - 8) Color Palette: 10 bit/1.07 billion colors.
 - 9) Lamp – 330 W; estimated life of 3000 hours.
 3. Manufacturer: Epson BrightLink 1485FI or similar Interactive Laser Projector – 1080p resolution, 5000 lumens . Mounting Bracket Epson Ultra Short Throw Wall Mount, Part # V12HA06A0
 4. Whiteboard for Ultra-Short Throw Interactive Projectors
 - a. Epson 100" Whiteboard for Projection and Dry Erase (16:10)
 - b. Bottom edge of whiteboard mounted 36" AFF or at a height that allows adequate viewing.

5. Laser Projectors:
 - a. Ceiling mounted with the following features:
 - 1) Brightness: 6500 ANSI Lumens minimum.
 - 2) Resolution: Native 1920 x 1200.
 - 3) Power: 415 Watts 100V – 240V .
 - 4) Lens Shift: Horizontal +/-20% & Vertical +/-50% .
 - 5) Image Size: 50.11" - 499.69"
 - 6) Throw Ratio: 1.35:1 – 2.20:1 .
 - 7) Internal Speakers: 10.0 Watts Mono .
 - 8) Aspect Ratio: 16:10.
 - 9) Contrast Ratio: 1000:1.
 - 10) Audio/Video Inputs:
 - a) HDBaseT: RJ-45
 - b) HDMI 2.3 (HDCP) x 2.
 - c) Network: RJ-45 .
 - d) RS232: DB-9pin .
 - e) USB x 2.
 - f) Wireless Networking
 - 11) Control: Full function control on unit; wireless (IR) remote; mouse with laser pointer.
 - 12) RS-232C Control and service port.
 - 13) Power Management: Auto shut-off.
 - 14) Economy Mode.
 - 15) UL listed.
 - 16) Security – Cable Locking System.
 - b. Manufacturer: Epson L690U or similar Laser Projector-WUXGA resolution, 6500 lumens .
6. Projection Unit Mounting Bracket:
 - a. Provide conventional ceiling universal , ceiling mounted bracket as recommended by the manufacturer.
 - 1) Provide tamperproof hardware.
 - 2) Security locking device with aircraft cable.
 - 3) Extension pipe: Diameter 1-1/2", Length as required for mounting height.
 - 4) Stabilization Bars (above accessible ceiling) to prevent projector sway.
 - 5) Lateral shift assembly.
 - 6) Finishing ring for extension pipe through ceiling and low-voltage cabling through ceiling.
 - 7) Manufactured by Chief RPA Projector Security Mount (Lock A) - RPAA1, Chief CMS0203 Adjustable Extension Column, and Chief CMA 115W Ceiling Plate.
 - b. Provide Suspended ceiling mount tile for 2' x 2' or 2' x 4' ceiling.
 - 1) Tile bridge to eliminate tile sag.
 - 2) Knockout for cable pass-thru and receptacle backbox.
 - 3) Chief KITES003PW.
7. Commercial Grade Display:
 - a. Digital Signage
 - b. Conference Room
 - c. Classroom

- d. VESA mounting holes must be compatible with wall mount
- e. 4K resolution
- f. RS-232c Control Port
- g. Minimum 3 HDMI Inputs
- h. Interactive Touch Panel Display:
- i. IR Touch Technology .
- j. 98".
- k. Resolution 4K UHD.
- l. Integrated speakers (2x 20W).
- m. Inputs: USB Type-C, HDMI 2.0, USB Type-B, USB Type-A, MIC, HDMI IN 2.0, Display Port 1.2, USB Type-B, USB 3.0 Type C, USB 3.0 Type-A, USB 3.0 Type A, HDMI OUT 2.0, RS232, RJ45, OPS, SPDIF and Audio Line out.
- n. Up to 64GB Expandable Storage.
- o. Adjustable wall mount kit.
- p. Manufacturer: Basis of Design: NewLine TT-9821Q
- 8. Video Conferencing Display
 - a. Software Compatibility RoomOS 11.15 or later,
 - b. Microsoft Teams Rooms on Android
 - c. Fully integrated main unit is delivered with Multi-Touch 55" or 75" 4K LCD display,
 - d. 2 x 48 MP cameras – wide and main field of view,
 - e. Integrated multi-channel speakers and woofer
 - f. 2 active pens
 - g. Wall mount kit (when wall stand or floor stand is selected, the wall mount kit is no longer included)
 - h. Power cord according to country specified in order
 - i. Lifting handles
- 9. Wall Mount Types:
 - a. X-Large TV's (75"-100") Chief XTM1U X-Large Fusion Micro-Adjustable Tilt Wall Mount
 - b. Large TV's (55"-75"), Chief LTM1U Large Fusion Micro-Adjustable Tilt Wall Mount
 - c. Medium TV's (32"-55"), Chief MTM1U Medium Fusion Micro-Adjustable Tilt Wall Mount
 - d. A different make/model of wall mount may be used if it meets the load/size requirements of the TV and has a security lock system.
- 10. Speakers:
 - a. Flush Recessed Ceiling Mounted Speaker (Type LS) Classroom:
 - 1) 6.5" woofer.
 - 2) .75" tweeter.
 - 3) Frequency Range: 75 Hz – 20 kHz.
 - 4) Power Capacity: 150W continuous, 75W pink noise.
 - 5) Sensitivity: 89 dB, 1W @1m.
 - 6) Multi Tap Transformer: 70V / 100V.
 - a) Taps: 60W, 30W, 15W, 7.5W.
 - 7) Coverage Angle: 110 degrees conical.
 - 8) Suspended ceiling bracket.
 - 9) Formed steel back cans.
 - 10) Manufacturer: Extron SF 26CT.
 - b. Surface Mounted Speakers:
 - 1) 6.5" woofer.
 - 2) 1" tweeter.
 - 3) Frequency Range: 65 Hz – 19.2 kHz.

- 4) Power Capacity: 150W continuous, 375W program.
 - 5) Sensitivity: 95 dB, 1W @1m.
 - 6) Multi Tap Transformer: 70V / 100V.
 - a) Taps: 120W, 60W, 30W, 15W.
 - 7) Coverage Angle: 110 degrees conical.
 - 8) Suspended ceiling bracket.
 - 9) Formed steel back cans.
 - 10) Manufacturer: Basis of Design: Extron SM 26 .
 - c. Pendant Speakers
 - 1) Frequency range: 70 Hz to 20 kHz, -10 dB, full space
 - 2) Power Capacity 65 W (rms) continuous pink noise, 130 W (rms) continuous program
 - 3) Sensitivity 86 dB SPL, 1W, 1m, full space
 - 4) Power Handling: 200W continuous @ 8 ohms
 - 5) Continuous Max Output: 116 dB (122 dB Peak)
 - 6) 70V/100V Autoformer: 200W, 100W, 50W, 25W (@70V only)
 - 7) Nominal Beamwidth (H x V): 95° Conical
 - 8) Manufacturer: Basis of design Extron SF 26PT Sound Field 6.5" Two-way Pendant Speaker .
 11. Wall Mount Touch Panel "TP":
 - a. 7" capacitive touchscreen with 1024 x 600 resolution and 24-bit color depth.
 - b. High speed USB 2.0 port
 - c. Built-in Speaker
 - d. Mounted in two-gang junction box, or on a wall, lectern, or any flat surface, including glass .
 - e. Manufacturer: Extron TLP725M .
 12. Cable Cubby
 - a. Accommodates one AC or AC+USB Power Module, plus three Retractor modules, four AV cables, or two AAP AV Connectivity Modules
 - b. Retractor Trim Kit, Cable Pass-Through bracket, and AAP bracket included; Retractor modules, cables.
 - c. Integrated side clamps secure enclosure to the furniture surface
 - d. Top surface is available in black anodized or brushed aluminum finish
 - e. Manufacturer: Extron Cable Cubby 500
- F. Motorized Projection Screens:
1. Electrically operated projection screen for recessed ceiling installation consisting of case, screen, motor, controls, electric brake, limit switches, mounting accessories, and other components necessary for complete installation.
 2. Screens have tab-guide cable tensioning, are provided with 12 inches (30 cm) of black drop standard.
 3. Case may be mounted with 3/8 inch threaded rod at ends or along length, with lag screws through brackets, or with wire in a grid ceiling. Mounting brackets slide in channels on top of case, allowing brackets to be moved somewhat to avoid interference with conflicting building structures. Brackets may be locked in position by tightening set screws. For suspended type mounting, support rods will need to be provided under other specification sections.

4. Screen Case:
 - a. Extruded aluminum housing with white paint finish and stamped steel end caps suitable for installation in return air plenums. Bottom closure panel forms slot for passage of viewing surface and is removable for access to operating mechanism and viewing surface. Bottom perimeter flange provides support and trim for acoustical ceiling panels and trim for gypsum board ceiling.
 - b. Housing is symmetrical allowing for left and right hand motor locations and for viewing surface to unroll off front or back of roller.
 - c. Housing designed with internal junction box and plug-in wiring connections to allow housing to be installed and connected to building power supply separately from motor and viewing surface.
 5. Roller: 3 inches diameter steel or aluminum tube mounted on zinc plated brackets with double row radial ball bearings. Roller mounted on vibration insulators.
 6. Viewing surface securely attached to roller at top and at bottom to weighted dowel. Provide each side of viewing surface with black masking borders and tab-guide cable tensioning system to maintain even lateral tension and to hold surface flat.
 7. Closure Door: Equip housing with independently motorized closure door that opens into screen housing.
 8. Viewing Surface:
 - a. Material: Matte white vinyl surface laminated on woven fiberglass base and surface is washable, flame resistant and mildew resistant; fiberglass matte white surface.
 - b. Size of viewing surface as shown on Drawings.
 - c. Edge Treatment: 1-1/2 inches wide black masking borders.
 9. Motor:
 - a. Type: 110-120 VAC, 60 Hz 3 wire, instantly reversible, lifetime lubricated, and equipped with internal thermal overload protector, electric brake and pre-set accessible limit switches.
 - b. Mount inside screen roller on rubber vibration insulators.
 10. Controls:
 - a. Low Voltage Control: Control station without switches for interface with master control system (Media Controller). Wiring from switches or receivers to low voltage control unit to be 24 V.
 11. Serial Control (RS232): Interface to allow motorized screen to be controlled via RS232. Equip interface with override switch permitting independent operation of screen.
 12. Manufacturer: Da-Lite Cosmopolitan Surface Mounted 16x10, Silent Motor, Matte White, and Built-in LVC. Da-Lite Advantage Electrol Ceiling Recessed, 16x10, Silent Motor, Matte White, and Built-in LVC
- G. Miscellaneous Equipment:
1. Take Over Relays:
 - a. Provide emergency take-over relays for each amplifier wired to the main public address system.
 - 1) Under normal conditions, the speakers are to be connected to the main public address system through matching transformers.
 - 2) When the amplifier is activated for local use, the speakers shall switch to the local amplifier.
 - 3) Upon initiation of an announcement from the main public address system, if the local system is in use, the speakers shall switch back to the main public address system.

- 4) Provide the required relays, wiring and transformers to accomplish the above.
 - b. Note that public address speakers are located in these spaces since it is expected that the systems will not be left energized when not in use.
2. Lecterns
 - a. Spectrum Industries Media Manager Elite
 - 1) 12RU Equipment Rack
 - 2) Side Drawer for Document Camera
 - 3) Overbridge on top of lectern with cutouts for touch panel and cable cubby
 - 4) Space for Computer Monitor
 - 5) Laminate, Metal Color, Edge Color, and Wood Trim to be determined by Division Dean
 - 6) Flip-up Side Shelf
 - 7) 3" swivel locking twin-wheel casters
 - 8) Keyboard Tray
 - 9) Dimensions: 32.75"W x 26.12"D x 21.72"H, Weight: 266lbs.
 - b. Spectrum Industries Freedom XRS Elite
 - 1) ADA Compliant electric adjustable height worksurface from 32"-40" H
 - 2) Overbridge on top of lectern with cutouts for touch panel and cable cubby.
 - 3) Equipment Rack on casters; Front rack rail: 14RU, Rear rack rail: 9RU
 - 4) Flip-up Side Shelf
 - 5) Keyboard Tray
 - 6) 3" swivel locking twin-wheel casters
 - 7) Laminate, Metal Color, Edge Color, and Wood Trim to be determined by Division Dean
 - 8) Dimensions: 30" W x 22"D x 29"H, Weight: 295lbs.
 - c. Spectrum Industries Inspiration Plus Lectern
 - 1) Overbridge on top of lectern with cutouts for touch panel and cable cubby
 - 2) 19RU Equipment Rack
 - 3) Flip-up Side Shelf
 - 4) Keyboard Tray
 - 5) 3" swivel locking twin-wheel casters
 - 6) Laminate, Metal Color, Edge Color and Wood Trim to be determined by Division Dean
 - 7) Dimensions: 21.5" W x 18.75" D x 42" H, Weight: 105lbs
 - d. Rack
 - 1) Furman Power Conditioner M-8X2
 - 2) Dell Optiplex SFF 7020 Desktop PC with Custom Rack Kit
 - 3) Extron IN IPCP Q 4K Presentation Switcher
 - 4) Middle Atlantic D2 2RU Rackmount Drawer
 - 5) Cisco Meraki MS130 Compact Switch
3. Mobile Furniture Rack:
 - a. Dimensions:
 - 1) 42" H x 19" W x 27.37" D.
 - 2) 20 RMU spaces.
 - b. 19" rack rail with 10 – 32 mounting holes front and rear.
 - c. Vented locking rear and front doors.
 - d. Vented side panels.
 - e. Constructed with 11 gauge steel.
 - f. Painted with iron phosphate coating for rust prevention and paint adhesion. Cabinet finish: black.

- g. Provide vented panels for unused openings.
 - h. Vertical and horizontal wire management.
 - i. Label Cabinet: AV System.
 - j. Provide caster base.
 - k. Manufacturer: MidAtlantic MFR Series Floor Standing Rack
- 4. Cabinet Equipment:
 - a. Furman Power Conditioner M-8x2
 - b. Dell Optiplex SFF 7020 Desktop PC with Custom Rack Kit
 - c. Extron IN1808 IPCP Q 4K Presentation Switcher
 - d. Middle Atlantic D2 2RU Rackmount
 - e. Cisco Meraki MS 130 Compact Switch
 - f. Extron TLP1025M Touch Panel
 - g. Flip-up Computer Monitor – Rack Mountable
 - h.
- H. Annotation Monitor:
 - 1. 22" Computer Monitor .
 - 2. 1920 x 1080 at 60 Hz .
 - 3. HDMI, DisplayPort, VGA, USB 5Gbps
 - 4. HDCP compliant.
 - 5. MAC and PC compatible.
 - 6. Desk mount tilt stand.
 - 7. Battery free pen.
 - 8. Manufacturer: Dell P2222H .
- I. Document Camera:
 - 1. Lighting Source:
 - a. Upper: White LED x2
 - b. Brightness: 250 lx or above @ A3 shooting area
 - 2. Imaging Element:
 - a. Pick-up device: ½.7" CMOS sensor
 - b. Effective Pixels: 1920 x 1080, 2 megapixels
 - c. White Balance: Auto
 - d. Exposure: Adjustable
 - e. Brightness: Adjustable
 - 3. Frame Rate:
 - a. 30 fps max.
 - 4. Functions:
 - a. Image Rotation: Camera Head Rotation: 180 degrees (Horizontal/Vertical)
 - b. Internal Memory: SD card slot (SD/SDHC only)
 - 5. Output Signals/Resolution:
 - a. VGA: SXGA (1280 x 1024), XGA (1024 x 768), WXGA (1280 x 800), HD (1360 x 768), 1080p (1920 x 1080)
 - b. USB: VGA, SVGA, XGA, SXGA, WXGA, 720p, 1080p
 - c. HDMI: 480p/720p/1080p
 - 6. Optics:
 - a. Capture Area: Max 11.7" x 20.7" (at 1080p); 11.7" x 16.5" (at XGA)
 - b. Lens: F-number: 3.4-5

- c. Zoom: 10x digital zoom, 12x optical zoom
- d. Focus: Automatically with one-touch button
- e. Iris: 250 lx or above @ A3 shooting area

2.3 CABLES

- A. Utilize factory manufactured patch cords in lieu of field terminated cables and components at rack connections and wherever possible.
 - 1. Utilize industry standard color coded connectors.
 - 2. Verify patch cord length and routing through sleeves/conduits prior to submittal stage.
 - 3. Utilize compression type connectors for all field terminated components where required. Provide industry standards identifiable color rings indicating connection type.
- B. All cabling shall be plenum rated.
- C. Provide all video cabling/connectors to produce the optimal video signal available from the source to the display as available from the equipment and video switcher.
- D. Shielded Twisted Pair Cable SF/UTP connecting from DTP output of presentation switcher to the projector.
- E. Unshielded Twisted Pair CAT6A from MDF room to the Meraki Compact Switch inside the lectern.
- F. Unshielded Twisted Pair CAT6 connecting from the Meraki Compact Switch to the projector.
- G. Shielded Twisted Pair Cable SF/UTP connecting from the lectern PC to the Epson 1485Fi projector for USB extension.
- H. Unshielded 16-gauge, 2 Conductor cable connecting from the Amplifier output to each speaker.
- I. Lectern Cable Cubby: 9' HDMI male to male, 9' USB-C (HDMI male to USB-C male), 9' male to male Ethernet, and 6' USB male to female.

2.4 AUDIO/VISUAL OUTLETS

- A. Coordinate A/V jacks/couplers with structured cabling system manufacturer's components to provide a complete, uniform, aligned, modular jack assembly.
- B. Label all jacks so the end user can determine where they are cabled to.
 - 1. Have these labels documented in the as built drawings.

END OF SECTION 274111

SECTION 275116 - PUBLIC ADDRESS SYSTEMS

PART 1 - PRODUCTS

1.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1.
 - 2. Valcom
- B. Source Limitations: Source similar components from a single manufacturer unless otherwise indicated in the design. Coordinate the features of materials and equipment so they form an integrated system with components and interconnections matched for optimum performance of specified functions in the specific rooms.
 - 1. In cases where the specified product is discontinued, submit the nearest equivalent product by the same manufacturer for approval.
- 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.

1.2 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. System Functions:
 - 1. Selectively connect any zone to any available signal channel.
 - 2. Selectively control sound from microphone outlets and other inputs.
 - 3. The "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
 - 4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
 - 5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
 - 6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.
 - 7. Simultaneous voice communication, program source distribution to multiple/individual zones.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 .

The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
- D. Intelligibility: System must meet at least one of the following speech intelligibility metrics:
 - 1. A minimum Speech Transmission Index (STI) of 0.50.

2. A Common Intelligibility Scale (CIS) rating of 0.70 at representative points in the area of coverage.

1.4 SYSTEM DESCRIPTION

- A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
- C. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

1.5 LOUDSPEAKERS

- A. Recessed Ceiling Loudspeakers:

Basis-of-Design Valcom VIP-120A with V-9916M Product: Subject to compliance with requirements, provide the product as indicated on the Drawings.

Pendant Mounted Loudspeakers:

Basis-of-Design Valcom VIP-415 with V-1093-BK: Subject to compliance with requirements, provide the product as indicated on the Drawings.

1.6 CONDUCTORS AND CABLES

- A. Cables:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product as indicated on the Drawings.
 2. Provide soft drawn annealed stranded copper of not less than 98 percent conductivity in all conductors.
 3. Provide plenum or underground cable where required by code.
 4. Provide cable of sufficient size to maintain <0.5dB loss throughout the entire circuit but not smaller than 16 AWG for 70v systems and 12 AWG for low impedance systems.
 5. Provide 1-pair stranded copper conductors between devices without splices or taps unless otherwise noted.

END OF SECTION 275116

SECTION 275314 - GPS WIRELESS MASTER CLOCK SYSTEM

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. It is the intent of this specification to establish a standard of quality, features, and functionality. In addition, it is intended to standardize on one manufacturer for the master clock system. Acceptance of manufacturer does not exempt them from meeting the specification in its entirety. Acceptable manufacturers are:
1. Primex.
 - a. Primex, Inc. 965 Wells St, Lake Geneva, WI 53147 | Phone: (855) 602-2934 | info@primexinc.com | www.primexinc.com

2.2 SYSTEM REQUIREMENTS

- A. Wireless master clock system with wireless transmitter, wireless repeater, wireless analog clocks. System shall have the ability to interface to the following systems:
1. Data Network Servers: For network time synchronization.
 2. Public Address Systems: For time tone/bell synchronization.
 3. Telephone System: For telephone time synchronization.
 4. Video Distribution System: For System time synchronization.
- B. Each clock in the system shall receive and transmit the wireless signal allowing it to be used as a repeater while boosting the signal across the system. The clocks shall be designed to automatically work together without interference with each other. The quality of the signal shall be increased with the addition of clocks to the system.
- C. A single transmitter shall be sized to provide a signal throughout the building.
1. Provide calculations from the manufacturer verifying transmitter size and wattage to allow coverage of the entire building/facility or campus.

2.3 MASTER CLOCK SYSTEM HEAD-END EQUIPMENT

- A. Description: Microprocessor-based, software-controlled unit complying with Class A device requirements in 47 CFR 15.
1. Programming and control switches.
 - a. Provides programming cues when system is being programmed.
 2. Output Circuits for Power and Correction of Secondary Indicating Clocks .
 3. Modem and PC interface software suitable for remote programming.
 4. Circuits for Audible and Visual Signal Devices: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, five A minimum. A minimum of two circuits.
 5. Circuits for Programmable Switching of Remote Equipment and Circuits: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, 5 A minimum. A minimum of circuits.
 6. Power Supplies: Capacity for internal loads and power-and correction circuits of connected clocks.

7. Enclosure: Metal cabinet with locking front panel. When cabinet is locked, display indication shall be visible on or through front panel face. Arrange cabinet for surface, semi recessed, or flush mounting as indicated.
 8. Housing: Rack-mounting metal enclosure with display indication visible on front panel face.
 - a. Reinforce mounting and attachment capable of resisting seismic forces described in Section 270548.16 "Seismic Controls for Communications Systems."
 9. Battery Backup for Time Base: Lithium battery to maintain the timekeeping function and retain the programs in memory during outage of normal ac power supply for up to 10 years.
- B. Electrostatic Discharge Resistance: Master Clock shall be tested and certified according to IEC 61000-4-2 in both human-discharge and direct-injection modes. Diagnostic Administration:
1. The master clock system controller shall provide an RS232C serial data port for connection to a computer for on-site diagnostics or via a modem to a remote computer for off-site diagnostic functions by the distribution or manufacturer personnel. The system shall maintain statistics of operations of the main system functions for use by the individual administrating the system. The minimum diagnostics shall include:
 - a. Check active list of activity within the system.
 - b. I/O Diagnostics shall enable the checking of each line and each device connected in the circuit.
 - c. Capability of checking each link and the ability to remotely block a link from the system if found defective.
 - d. A modem shall be included with system.
- C. Equipment Mounting:
1. GPSmaster clock shall be rack mountable in a standard 19 inch rack. Provide all necessary power, cable, and connections as recommended by the manufacturer for proper installation.
 2. GPSmaster clock shall be installed in local Telecommunication Room .
 3. Cable Connection Sealant: Radio Shack Coaxial Cable Connector Sealant 278-1645, or approved equal electrical grade silicone sealant.

2.4 WIRELESS TRANSMITTER / TRANSCEIVER

- A. The wireless transmitter shall be microprocessor based and integrated or connected to GPS master clock for time signal generation. The transceiver shall transmit time signals to wireless secondary clocks throughout the facility.
1. Transmit minimum distances of 1000 meters.
 2. Inputs: RS485, 59 minute, 58 minute, sync wire.
 3. Ten (10) year battery backup.
 4. Power Input: 35 watts.
 5. Voltage Inputs: 85-265 VAC, 50/60 Hz.

2.5 BELL AND TONE SYNCHRONIZATION AND GENERATOR

- A. Provide capability to remotely distribute sound and tone signals through the PA System speakers from the scheduling software to audibly notify occupants.

2.6 PERIPHERAL EQUIPMENT

A. Analog Secondary Clocks:

1. Maintain correct synchronized time and transmit time-correction signals over dedicated system wiring from a master clock to any one type(s) of secondary indicating clocks, including the following:
 - a. Analog Synchronous Clocks: Correct for minute- and second-hand synchronization at least once each hour and for hour-hand synchronization at least once each day.
2. Initiate and execute programs for scheduled automatic operation of remote devices. Include audible signal devices and visual signal devices.
3. Provide for manual control of programmed signal and equipment – switching circuits.
4. Communicate with remote PC for access to UTC time base and to permit programming from remote location.
5. Maintain system access security with a minimum of one level of user-access control to restrict use of system controls to authorized personnel. Access to user programming and control functions is accomplished by entering a minimum three-digit code. Access levels include the following:
 - a. Access to review existing programs only.
 - b. Access to normal system operating controls.
 - c. Access to all user-programming and control functions.
 - d. Regulate system timing functions using power-line, frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator.
6. Provide programming multiple independent event schedules into memory and running them simultaneously for different output circuits.
 - a. Quantity of Programmable Schedules: 18 minimum
 - b. Number of Weekly Events that can be programmed for each schedule: 300, minimum.
 - c. Simultaneous operation of independent schedules shall be limited only by the number of signal-device and equipment-switching output circuits.
 - d. Advance Programming for Automatic Holiday Schedule Changes: Number of schedule changes that can be programmed to suit holidays and vacations shall be 50, and each change may be programmed up to a year in advance to occur on any day of the calendar year.
7. Provide manually initiated daylight savings time correction.
8. Provide adjustments to master clock output signals. Duration of momentary signal shall be individual programmable for each signal and equipment-control output circuit from 1 to 99 seconds. Signals shall be programmable for either on or off switching to suit equipment-operation scheduling.

2.7 SECONDARY INDICATING CLOCKS

- A. Analog Clock: Equipped with a sweep second hand. Movement shall be driven by self-starting, permanently lubricated, sealed synchronous motor equipped with a correcting solenoid actuator, or be a microprocessor-based, second impulse unit, compatible with the master clock.
- B. Digital Clock: Microprocessor-controlled unit complying with Class A device requirements in 47 CFR 15, with red LED digital time display of hours, minutes, and seconds.
 1. Display Height: 2-½-inch Clock: Hour and minute numerals readable at 50 feet.
 2. Display Height: 4-Inch Clock: Hour and minute numerals readable at 100 feet.
 3. Display Format: Selectable between 12-hour with "PM" LED display and 24-hour formats.

4. Connections for Power and Correction:
 - a. Wired synchronous connection to the master clock for both operating power and correction.
 - 1) Time-Base Backup: Internal alkaline battery shall back up internal time base to maintain timekeeping during power outages of up to six days' duration.
 - 2) Correction by RS485, Ethernet, or similar data line with operating power supplied over a separate connection.
 - 3) Power Connection for Secondary Indicating Clocks: Plug connector.
- C. Interval-Timer Clock: Digital microprocessor-controlled, 4-inch unit with 2-½", red LED digital display for hours and minutes and 1-5/16 inch display for seconds; a separately mounted, mode-controlled switch; and the following features:
 1. Display Visibility: Hour and minute numerals readable at 30 feet in normal ambient light.
 2. Operating Modes: Normal Clock operates as a regular secondary system clock, displaying corrected time in normal display configuration, selectable between 12- and 24-hour formats, with "PM" digital display for 12-hour format.
 - a. Mode-Selector Switch: Push-button or rotary, multiposition type, flush mounted; with start, stop, and reset capability in both count-up and count-down modes.
 - b. Audible tone signal: Housed in clock or mode-selector-switch box. Sounds at end of preset up or down count.
- D. Provision for Time-Tone-Unit Installation: Equip indicated clocks for housing or mounting in an acoustically treated and baffled speaker compartment specified in Section 275116 "Public Address and Mass Notification Systems."
- E. Secondary Indicating Clock Characteristics:
 1. Clock Type: GPS synchronized time system, 12.5" Traditional clocks with -P (Calypso)
 2. Face Configuration: Single.
 3. Mounting: Surface.
 4. Nominal Dimensions: 12.5"
 5. Casing Finish: Black
 6. Special Environmental Conditions: None
 7. Dial Face Color: Black
 8. Analog Clock Crystal: Clear.
 9. Face Color: White
 10. Seconds Display: Yes.
 11. Battery Backup: Yes.
 12. Interval-Timer Display: Yes.



2.8 PROGRAM SIGNAL DEVICES

- A. Bells: Heavy-duty, modular, vibrating type with the following sound-output ratings measured at 10 feet.
 1. Turn over items: FCC license information
- END OF SECTION 275314

SECTION 281300 - ACCESS CONTROL/INTRUSION DETECTION SYSTEM

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

A. Manufacturers:

1. Verkada's Basis of Design.
2. All access control hardware and software shall be of a single manufacturer including Host system, controller panels, and input and output terminal modules.

2.2 HARDWARE REQUIREMENTS

A. Network Controllers:

1. The Network Controllers shall be a fully standalone processor capable of making all access control decisions without the involvement of the Host Server based on a set of parameters passed to the sub-controller from the host.
 - a. The Network Controllers shall support eight (8) or sixteen (16) card readers in addition to either 256 input points or 128 input points and 128 output points. It shall further support up to 12 facility codes per reader, 40 unique holidays, 8 access group and time zone pairs.
 - b. Memory Requirements:
 - 1) Minimum Number of Cards: 12,000 expandable to 100,000.
 - 2) Minimum Number of Historical Transactions: 5,000 expandable to 45,000 at full card capacity.
 - c. The controller shall require no firmware changes and shall use flash memory modules to provide non-volatile storage of both data and operational code.
 - d. Each controller shall be provided with built-in hardware to support hard-wired communications between the controller(s) and readers of up to 4000 feet.
 - e. Communications between the controller(s) and the host server shall be via Ethernet TCP/IP at 10Mbps minimum. There shall be an alternate communications path to the host via a secondary IP address such that in the unlikely even the primary IP address/network is down an alternate communications path may be established.
 - f. An alarm summary relay shall be built-in to the controller motherboard. The alarm relay shall be activated whenever a connected alarm point transfers to the alarm state and whenever soft alarms become active.
 - g. A tamper switch shall be attached to the inner surface of the controller enclosure. The tamper switch shall change state whenever the enclosure door is opened to signal the SMS of the condition. The tamper switch input shall be user programmable to be suppressed, to be recognized as an input point to be process by the alarm queue at the host computer, to printout at an optional printer connected directly to the controller, and to activate the alarm summary relay described above.
 - h. The standard AC linear power supply version of the controller shall include a battery module to back-up the controller's applications programs and database for 30 days after the failure of the primary AC power service. The controller database, the time clock, the transaction history, and all operator entered parameters shall be backed-up by the battery.
 - i. The controller shall provide built-in LED to indicate whether the controller is properly communicating with the host computer.

- j. Alarm monitoring and Output Control terminal boards. Intelligent alarm monitoring and output control terminal boards shall be plug-in modules to the Network Controllers with the following functionality:
 - 1) Sixteen 2-state alarm input points.
 - 2) Eight 4-state supervised alarm input points.
 - 3) Eight 2-state alarm input points and eight SPDT output relays.
 - 4) Eight 4-state supervised alarm-input points and eight SPDT output relays.
- 2. Signature capture device shall be connectable via a serial port interface communicating at 9600 BPS. Signature capture device shall be able to display the signature at the capture pad as well as on-screen.
- 3. Video Camera shall include fully software-controlled auto-focus and zoom capabilities to manual focus without zoom. Each camera option shall include necessary hardware, i.e. stand, data cable, and light source, as appropriate. The video capture cards associated with each camera shall offer crop capabilities within the software interface.
- 4. Manufacturer:
 - a. Verkada AC62

2.3 READERS – VERIFICATION DEVICES

A. General:

- 1. All readers shall be configured with the reader electronics mounted separately on the "secure" side of the door such that only the reader head/keypad and pilot lights are mounted in the reader housing on the "entry" side of the door.
- 2. All readers shall support the following technologies:
 - a. Multi-Technology
- 3. All readers shall be in compliance with the following standards:
 - a. ISO 14443A.
 - b. ISO 14443B.
 - c. ISO 15693.
 - d. All readers shall be multi-frequency capable.
 - 1) 125 KHz.
 - 2) 13.56 MHz.

B. SmartCard Technology with Proximity Capability - Furnish and install the reader style as shown on the Drawings or as called for in this Specification:

- 1. Proximity Reader:
 - a. The reader shall be integrated and contain all reader electronics inside a single polycarbonate enclosure; exterior, vandal proof, weatherproof housing.
 - b. The reader shall operate when mounted on a variety of surfaces including metal. Maximum read range degradation when mounted on a metal surface shall be 50 percent.
 - c. The reader shall contain an integral color LED and audio tone to indicate if the card has been successfully read.
 - d. The reader shall be 3.3 inch x 4.8 inch x 1 inch maximum.
 - e. Read range shall be up to 8 inches.
 - f. The reader shall be rated for normal operation from -13 to 150 degrees F.
 - g. Manufacturer: HID Verkada AD34.

2. SmartCard Proximity Reader with Keypad:

- a. Provide proximity reader with integrated keypad in polycarbonate enclosure for outdoor use. An LED shall flash green and a beeper shall sound indicating that the card number and keypad passcode has been successfully read. Integral tamper switch shall provide notification of reader tampering. Read range shall be up to 24 inches. The reader shall be rated for normal operation from -13 to 150 degrees F.
- b. Manufacturer: Verkada AD64

2.4 SMARTCARDS

- A. System shall provide full compatibility with contactless SmartCards read/write technology.
- B. Digital Proximity Command Key (CARD):
 1. Single coil passive proximity card.
 2. Multiple technologies supported: proximity, magnetic stripe, bar code, photo ID.
 3. ISO Compliant: IEC 15693.
 4. Memory capacity range 64 to 64K bytes.
 5. Unique numeric encoded data embedded in circuit of card.
 6. Active circuit cards (requiring batteries) are not acceptable.
- C. Polyester, Rigid Card Wipe Magnetic Stripe, Bar Code:
 1. Capable of SmartCard chip insertion.
 2. Color imaging capable.
 3. Hole punch for vertical or horizontal image display.
 4. Dimensions: ISO compliant.
 - a. Thickness: .032 inches.
 - b. Length: 3.32 inches.
 - c. Width: 2.125 inches.

Bar code shall be unable to be copied.

5. Manufacturer: Verkada Prox Cards (Standard 26-bit)

2.5 ELECTRIC STRIKE

- A. Electric strike/lock release provided by hardware manufacturer. Connections by Division 26. Interface door electrical strike release system to local card access control panel at the local doors terminal cabinet serving that area.

2.6 DOOR LATCH NOTIFICATION

- A. Provided by door hardware manufacturer and connected by Division 26.

2.7 SECURITY OVERRIDE DEVICE

- A. Provided by door hardware manufacturer and connected by Division 26.

2.8 DOOR CONTACTS

- A. Provide, where shown on Drawings, UL listed magnetic flush mounted contacts and magnets. Each contact shall be provided with matching magnet. All contacts shall be hermetically sealed for long term 10,000,000 cycle contact. Switch contacts shall be of the reed blade type with rhodium plating eliminating cold-welding; sticking and resistance build-up. All switches shall be 100 percent factory tested prior to installation. Coordinate with door frame manufacturer.
- B. Manufacturer:
 1. Interlogix 1076C-M (Recessed)

2. Interlogix 1125TW-M (Fire Rated Opening)
3. Interlogix 2505A-L (Surface Mount/Gate)
4. Interlogix 2205A-L (Overhead)

2.9 REQUEST TO EXIT DEVICES

- A. Motion Sensors: Passive infrared type designed for hands-free operation.
 1. Coverage Pattern: Provide adjustable coverage pattern using masking kit. Sensor shall have adjustable aiming of 14 degrees vertically.
 2. Provide a walk test/activation LED indicator.
 3. Relay latch time adjustable to 60 seconds. Provide two (2) Form C contacts rated 1 amp at 30 VDC for resistive loads.
 4. Sensors shall be RFI immune in the 26-900 MHz range.
- B. REX devices that are part of the electrified hardware will be provided by others. Contractor shall completely wire (power and control) hardware to the access control system.
- C. Manufacturer: Bosch DS 160

2.10 WIRE AND CABLE

- A. Comply with requirements of Section "Wires and Cables" with stranded copper conductors. Size conductors as indicated, but not less than recommended by system manufacturer.
- B. Utilize unshielded, twisted pair cable (UTP) installed in conduit system.
- C. Furnish and install standard manufacturer's cable assemblies for components as recommended by the system manufacturer. Include connections for electric door strikes, card reader connections, and all required peripheral devices.

PART 3 - EXECUTION – NOT USED

END OF SECTION 281300

SECTION 282300 - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. Video-signal format shall comply with NTSC standard, composite interfaced video. Composite video-signal termination shall be 75 ohms.
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
 - 1. Minimum Protection for Power Connections 120V and more: Auxiliary panel suppressors comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
- C. Minimum Protection for Communication, Signal Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Video Surveillance System shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. 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 NECA 1.
- D. Comply with NFPA 70.

2.3 IP NETWORK CAMERA

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bosch Security Systems, Inc.
 - 2. Pelco
 - 3. Or approved equal by Pasadena City College
- B. General Characteristics:
 - 1. The camera shall be capable of operating in an indoor environment.
 - 2. The camera shall offer 2592 x 1944 (5MP) sensor pixels.
 - 3. The camera shall offer tamper detection and Essential Video Analytics
 - 4. The camera shall offer two-way full duplex audio communication.
 - 5. The camera shall have a built-in active infrared illuminator (NDI-5503-AL only)
 - 6. The camera shall provide a CVBS (PAL/NTSC), 1 Vpp, BNC, 75 Ohm analog output that allows hybrid video output.

7. The camera shall utilize Intelligent Dynamic Noise Reduction (iDNR) technology to reduce the bitrate and storage requirements by removing noise artifacts. The camera shall offer Intelligent streaming possibilities.
 8. The camera shall have a gyrosensor / accelerometer
- C. Imaging Requirements
1. The camera shall offer a 1/2.9-inch CMOS image sensor.
 2. The camera shall produce a video resolution of 3071x1728 pixels (MP 5MP) at 30 fps with a 16:9 aspect ratio.
 3. The camera shall produce a video resolution of 2688x1512 pixels (MP 4MP) at 30fps with a 16:9 aspect ratio.
 4. The camera shall produce a video resolution of 2304x1296 pixels (MP 3MP) at 30 fps with a 16:9 aspect ratio.
 5. The camera shall produce a resolution of 1920 x 1080 pixel (HD 1080p) at 30 fps with a 16:9 aspect ratio.
 6. The camera shall offer an upright mode
 7. The camera shall be fitted with a board-mounted fixed varifocal 3 to 10 mm, DC Iris, F1.3 lens with a lens view angle of: 29° - 92° (Horizontal), 18° - 50° (Vertical).
 8. The camera shall have a wide dynamic range of 120 dB HDR.
 9. The camera shall have high sensitivity color (0.24 lx) and in monochrome (0.03 lx).
 10. The camera shall offer a minimum sensitivity of 0.0 lx in IR mode (NDI-5503-AL only).
 11. The camera automatic electronic shutter shall offer a shutter speed of 1/30 (1/25) to 1/15000.
 12. The camera shall be capable of capturing and storing images using the following compression standards
 - a. H.265 MP
 - b. H.264 MP
 - c. M-JPEG
- D. Network Video:
1. The camera shall provide direct network connection using H.265, H.264 and M-JPEG compression and bandwidth throttling to efficiently manage bandwidth and storage requirements while delivering outstanding image quality.
 2. The camera shall allow full camera control and configuration capabilities over the network.
 3. The camera shall deliver video, at rates up to 30 images per second, via TCP/IP over a 10/100 Base-T, auto-sensing, half/full duplex, RJ45 Ethernet connection.
 4. The camera shall support AutoMDIX.
 5. The camera shall conform to the ONVIF Profile S and G standard.
 6. The camera shall conform to protocols: IPv4, IPv6, UDP, TCP, HTTP, HTTPS, RTP/RTCP, IGMP V2/V3, ICMP, ICMPv6, RTSP, FTP, Telnet, ARP, DHCP, SNMP (V1, MIB II), 802.1x, DNS, DNSv6, DDNS, SMTP, iSCSI, UPnP
- E. (SSDP), DiffServ (QoS), LLDP, SOAP, Dropbox, CHAP, Digest Authentication. -Night Vision (Infrared) (NDI-5503-AL only).
1. The camera shall have a 10 LED high efficiency array (850 nm) for effective night vision up to 98 ft. -
- F. Control:
- G. The camera shall be configured via a web browser or PC surveillance software. Connectors:
1. The camera shall have one RJ-45 for Ethernet.
- H. Electrical:
1. Power over Ethernet.

2. The camera shall conform to the IEEE 802.3af (802.3at Type 1) compliant Power over Ethernet network. Power level: Class 3.
- I. The camera shall consume 7 W (max). Access Security:
 1. The camera shall offer three levels of password protection.
 2. The camera shall support 802.1x authentication using a RADIUS (Remote Authentication Dial In User Service) server.
 3. The camera shall store an SSL certificate for use with HTTPS.
- J. Recording and Storage Management:
 1. The camera shall support iSCSI devices to allow video stream to be recorded directly to an iSCSI RAID array.
 2. The camera shall support iSCSI storage targets to enable the camera to function as a conventional DVR.
 3. The camera shall have an SD card slot that uses standard, off-the-shelf SD cards for local storage (up to 2TB).
 4. The local storage feature shall be capable of storage for Automatic Network Replenishment (ANR).
 5. Local Recording: Continuous recording, ring recording, alarm/events/schedule recording.
- K. Alarm Handling Features:
 1. The camera shall provide the capability on alarm to display up to a 31 character, programmable alarm message.
 2. The camera shall provide email alarm messaging with optional JPEG posting.
- L. Embedded Video Content Analysis:
 1. The camera shall be VCA enabled.
 2. The camera shall be capable of processing and analyzing video within the camera itself, with no extra hardware required.
 3. The camera shall be capable of detecting and sending alarms for abnormal events.
 4. The camera shall allow users to set up to 10 separate profiles and switch profiles based on a day/night or holiday schedules.
 5. The camera shall offer Essential Video Analytics that uses an Intelligent tracker to follow objects within the defined regions of interest
- M. Environmental:
 1. The camera shall operate in a -20°C to +50°C (-4°F to +122°F) temperature range.
 2. The camera can be stored in a -30°C to +70°C (-22°F to +158°F) temperature range.
 3. The camera can be operated/stored in 0% to 90% relative humidity (non-condensing).
- N. Mechanical:
 1. The camera dimensions shall be:
 2. Indoor Camera
 - a. Diameter 135 mm (5.32 in.)
 - b. Height 13.1 mm (5.14 in.)
 - c. The Camera weight shall be 1102g (2.43 lb) approx.
 - d. The camera shall have 3-axis adjustment (pan/tilt/rotation), plus zoom.
 - e. The camera color is RAL 9003 to RAL 9017.
 - f. The camera shall offer IP66 ingress protection (outdoor camera only).
 - g. The camera shall offer IK10 impact protection (outdoor camera only).

O. Accessories:

1. Mounts:

- a. BUB-CLR-FDO Clear polycarbonate bubble for dome camera.
- b. BUB-TIN-FDO Tinted polycarbonate bubble for dome camera.
- c. NDA-5031-PIP Interface plate to mount a camera to pendant or pipe, white; for indoor use.
- d. NDA-5030-PIP Interface plate to mount a camera to a pendant or pipe, white; for outdoor use.
- e. NDA-U-WMT Universal wall mount for dome cameras, white
- f. NDA-U-PMT Universal pipe mount for dome cameras, 31 cm, white
- g. NDA-U-PMAS Universal pole mount adapter, white; small.
- h. NDA-U-PMTE Extension for universal pipe mount, 50 cm, white
- i. NDA-U-PSMB Surface mount box (SMB) for wall mount or pipe mount.
- j. NDA-FMT-DOME In-ceiling flush mounting kit for dome cameras (Ø157 mm)
- k. NDA-ADT4S-MINDOME Surface mount box (Ø145 mm / Ø5.71 in) for dome cameras (use together with the appropriate dome adapter bracket).
- l. NDA-U-CMT Universal corner mount, white
- m. NDA-U-WMP Back plate for universal wall mount, corner mount and pole mount, white
- n. LTC 9230/01 Flat Roof Mount Adapter for mounting a unit in an upright position on flat surface.
- o. NDA-U-WMT Universal wall mount for dome cameras, white
- p. NDA-U-PMAL Universal pole mount adapter, white; large
- q. NDA-U-RMT Universal roof mount for dome cameras, white

2. Other:

- a. UPA-1220-60 Power supply for camera. 100-240 VAC, 50/60 Hz In; 12 VDC, 1 A Out; regulated. Input connector: 2-prong, North American standard (non-polarized).
- b. NPD-5001-POE Power-over-Ethernet midspan injector for use with PoE enabled cameras; 15.4 W, 1-port
- c. NDN-IOC-30M An IP66 certified cable for easy waterproof installation
- d. UPA-1220-60 Power supply for camera. 100-240 VAC, 50/60 Hz In; 12 VDC, 1 A Out; regulated. Input connector: 2-prong, North American standard (non-polarized).
- e. VG4-A-PSU0 Power supply, 24 VAC input. White, aluminum enclosure with cover, rated IP66 and IK 08. 100 W output.
- f. VG4-A-PSU1 Power Supply, 120VAC input, 24VAC output @ 96VA. White aluminum enclosure with cover. IP66 ingress. IK10 impact.
- g. VG4-A-PSU2 Power Supply, 230VAC input, 24VAC output @ 96VA. IP66 ingress. IK10 impact
- h. Bosch, FLEXIDOME IP indoor 5000i (IR) [NDI-5503-A(L)]
- i. Bosch, FLEXIDOME IP outdoor 5000i (IR) [NDE-5503-A(L)]

2.4 POWER SUPPLIES

- A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera and lens.

1. Enclosure: NEMA 250, Type 3.

2.5 CAMERA-SUPPORTING EQUIPMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bosch Security Systems, Inc.

2. Pelco.
 3. Or approved equal by Pasadena City College
- B. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.
- C. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action, and equipped with matching mounting brackets.
1. Scanning Operation: Silent, smooth, and positive.
 2. Stops: Adjustable without disassembly, to limit the scanning arc.
- D. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation, and equipped with matching mounting brackets.
1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
 2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
 3. Speed: 12 degrees per second in both horizontal and vertical planes.
 4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
 5. Built-in encoders or potentiometers for position feedback.
 6. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.
- E. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.
- F. Protective Housings for Fixed and Movable Cameras: Steel enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
1. Camera Viewing Window: Polycarbonate window, aligned with camera lens.
 2. Duplex Receptacle: Internally mounted.
 3. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
 4. Sun shield shall not interfere with normal airflow around the housing.
 5. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
 6. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
 7. Enclosure Rating: Nema 3R .

2.6 MONITORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bosch Security Systems, Inc.
 2. Pelco.
 3. Or approved equal by Pasadena City College
- B. Monochrome:
1. Metal cabinet units designed for continuous operation.
 2. Screen Size (Diagonal Dimension): Two 25" monitors at monitoring location to be determined by Security of Pasadena City College.
 3. Horizontal Resolution: 600 lines, minimum, at center.
 4. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, horizontal-hold, vertical-hold, and contrast controls.

5. Mounting: Adjustable tilting and training.
6. Electrical: 120-V ac, 60 Hz.

C. ASUS PB277Q or approved equal by Pasadena City College

2.7 NETWORK VIDEO RECORDERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bosch Security Systems, Inc.
 2. Pelco.
 3. Or approved equal by Pasadena City College
- B. External storage or internal 500-GB hard disk drive.
1. Video and audio recording over TCP/IP network.
 2. Video recording of MPEG-2 and MPEG-4 streams.
 3. Video recording up to 48 Mbps for internal storage and up to 100 Mbps for external storage.
 4. Duplex Operation: Simultaneous recording and playback.
 5. Continuous and alarm-based recording.
 6. Full-Featured Search Capabilities: Search based on camera, time, or date.
 7. Automatic data replenishment to ensure recording even if network is down.
 8. Digital certification by watermarking.
 9. Internal RAID storage or non-RAID storage of up to 1500 GB.
 10. Capable of adding external RAID storage up to 7000 GB for models with no internal storage.
 11. Full integration with LAN, Intranet, or internet through standard Web browser or video management software.
 12. Integrated Web server FTP server functionality.
 13. Supports up to 64 devices.

2.8 DIGITAL SWITCHERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bosch Security Systems, Inc.
 2. Pelco
- B. Quad Switch: For displaying images from four cameras on a single monitor. Provide color switcher if one or more cameras or monitors are in color.
1. Controls: Unit-mounted front panel.
 2. Resolution: 1920 x 1080 pixel (HD 1080p)
 3. Modes: Auto, manual, and alarm. In manual mode, each channel can also be viewed in single display mode. In the event of an alarm, alarming channel shall automatically switch to full screen. If several alarms are activated, channels in alarm shall be in auto-switching mode.
 4. Channel Loss Alarm: Audible buzzer; occurrence details shall be recorded.
 5. Time: Indicate date and time.
 6. Timing of Auto-Switcher: 1 to 30 seconds, selectable.
 7. Mounting: Standard 19-inch rack complying with CEA 310-E, or freestanding desktop.
- C. Manual Switch Bank: Low-loss, high-isolation, multiple-video switch to allow manual switching of multiple quad switches and cameras to a single output. Switches shall be illuminated.

- D. Sequential Switchers: Automatically sequence outputs of multiple cameras to single monitor and videotape recorder.
 - 1. Switching Time Interval: Continuously adjustable, 5 to 20 seconds minimum, with manual override.
 - 2. Skip-Sequential-Hold Switch: One for each camera, with LED to indicate active camera.
 - 3. Camera Identification Legend: Either on-screen message or label at skip-sequential switch.
 - 4. Alarm Switching: In the event of an alarm, alarming channel shall automatically switch the monitor to full screen.
 - 5. Mounting: Standard 19-inch rack complying with CEA 310-E.
- E. PTZ Controls: Arranged for multiple-camera control, with switches to select camera to be controlled.
 - 1. Pan-and-Tilt Control: Joystick type.
 - 2. Zoom Control: Momentary-contact, "in-out" push button.
 - 3. Automatic-Scan Control: A push button for each camera with pan capability that places camera in automatic-scanning mode.

2.9 IP VIDEO SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bosch Security Systems, Inc.
 - 2. Pelco.
 - 3. Or approved equal by Pasadena City College
- B. Description:
 - 1. System shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
 - 2. System shall have seamless integration of all video surveillance and control functions.
 - 3. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
 - 4. System design shall include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit shall provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
 - 5. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
 - 6. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
 - 7. Encoder/decoder combinations shall place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
 - 8. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices shall be provided for full performance of specified system.

2.10 VIDEO MOTION SENSORS (INTERIOR)

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Tyco International Limited.
 - 2. Or approved equal by Pasadena City College

- B. Device Performance: Detect changes in video signal within a user-defined protected zone. Video inputs shall be composite video as defined in SMPTE 170M. Provide an alarm output for each video input.
 - 1. Detect movement within protected zone of intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of two. Reject all other changes in video signal.
 - 2. Modular design that allows for expansion or modification of number of inputs.
 - 3. Controls:
 - a. Size of detection zones.
 - b. Sensitivity of detection of each protected zone.
 - 4. Mounting: Standard 19-inch rack complying with CEA 310-E.

2.11 CONTROL STATIONS

- A. Manufacturer: Subject to compliance with requirements, provide products by the following:
 - 1. Bosch Security Systems, Inc.
- B. Description: Heavy-duty, freestanding, modular, metal furniture units arranged to house electronic equipment. Coordinate component arrangement and wiring with components and wiring of other systems.
- C. Equipment Mounting: Standard 19-inch rack complying with CEA 310-E.
- D. Normal System Power Supply: 120 V, 60 Hz, through a locked disconnect device and an isolation transformer in central-station control unit. Central-station control unit shall supply power to all components connected to it unless otherwise indicated.
- E. Power Continuity for Control Station: Batteries in power supplies of central-station control units and individual system components shall maintain continuous system operation during outages of both normal and backup ac system supply.
 - 1. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portions of system served including audible trouble signal devices for up to four hours and audible and visual alarm devices under alarm conditions for an additional 10 minutes.
 - 2. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within 24 hours.

Annunciation: Indicate change in system condition and switching of system or component to backup power.

PART 3 - EXECUTION – NOT USED

END OF SECTION 282300

SECTION 283100 - FIRE ALARM AND MASS NOTIFICATION SYSTEMS

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. FACU and Equipment, proprietary to match existing equipment:
 - a. Edwards Systems Technology Inc., Division of United Technologies Corp. (UTC) - EST 3 Series.
 2. Non-System Air Sampling Detector System Equipment:
 - a. VESDA; a Division of Honeywell Group – VLP Series with tubing and accessories.
 - b. Fenwall – Analyzer Series with tubing and accessories.
 - c. Environment One System with tubing and accessories.
 - d. SAFE Fire Detection, Inc. – IFD Pro Series with tubing and accessories.
 3. Non-System IP Camera Detectors:
 - a. Fire Alarm Systems – Signifire.
 4. Non-System Carbon Monoxide Detectors:
 - a. ESL SafeAire – 240-CD.
 - b. Macurco, Inc. – CM-15/14A.
 - c. Telefire Fire and Gas Detectors Ltd. – GHD-2010N.
 5. Wire and Cable:
 - a. Comtran Corporation.
 - b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
 - c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
 - d. West Penn Wire/CDT; a division of Cable Design Technologies.
 - e. Pyrotenax CIC: 2-Hour Rated Cable.

2.2 EXISTING FIRE ALARM SYSTEM

- A. Compatibility with Existing Equipment: Fire alarm system and components shall operate as an extension of an existing system. All new equipment shall match existing to whatever extent practical to ensure compatibility, supervision, and functionality.

2.3 REGULATORY REQUIREMENTS

- A. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations and the requirements of the Authority Having Jurisdiction.
- 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. ANSI Compliance: Provide a fire alarm and detection system conforming to ASME A17.1.
- D. NFPA Compliance: Provide a fire alarm and detection system conforming to the requirements of the following publications:
1. NFPA 20 - Centrifugal Fire Pumps.

2. NFPA 70 - National Electrical Code.
 3. CEC Article 725 - Class 1, 2, and 3 Signaling Circuits.
 4. CEC Article 760 - Fire Protective Signaling Systems.
 5. NFPA 72 - National Fire Alarm Code.
 6. NFPA 90A - Air Conditioning Systems.
 7. NFPA 92A - Smoke Control Systems.
 8. NFPA 101 - Life Safety Code.
- E. The fire system installation company shall be licensed by the Project State to install fire alarm systems. A copy of the State fire alarm install license shall be submitted to the Engineer with shop drawing submittal.
- F. UL Listing and Labeling: Provide system and components specified in this Section that are listed and labeled by UL and specific references as follows:
1. UL 38 - Manually Actuated Signaling Boxes.
 2. UL 217 - Smoke Detectors, Single and Multiple Station.
 3. UL 228 - Door Closers-Holders for Fire Protective Signaling Systems.
 4. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
 5. UL 268A - Smoke Detectors for Duct Applications.
 6. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
 7. UL 464 - Audible Signaling Appliances.
 8. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
 9. UL 864 - Control Units for Fire Protective Signaling Systems.
 10. UL 1480 - Speakers for Fire Protective Signaling Systems.
 11. UL 1711 - Amplifiers for Fire Protective Signaling Systems.
 12. UL 1481 - Power Supplies for Fire Protective Signaling Systems.
 13. UL 1638 - Visual Signaling Appliances.
 14. UL 2075 - Safety Gas and Vapor Detectors and Sensors.
 15. The fire system shall comply with local building codes, and meet all requirements of the local Authorities Having Jurisdiction. The complete fire alarm system installation shall be listed by Underwriters Laboratories, Inc. (U.L.) Standard UUJS. All components of the fire system shall be U.L. listed.
- G. Factory Mutual (FM) Compliance: Provide fire alarm systems and components that are FM approved proprietary signaling systems.
- H. Single Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility for system components furnished.
- I. Americans with Disabilities Act (ADA) - Latest Edition: Comply with all related fire alarm installation and operating requirements in the Federal ADA law and local accessibility codes.

2.4 SYSTEM DESCRIPTION

- A. Noncoded, addressable system; multiplexed signal transmission dedicated to fire alarm service only.
1. Interface with existing fire alarm system.
- B. Smoke/Fire Zones:
1. Basically, each floor shall be group zoned according to the smoke partition construction, with further breakdown as to the device type. Refer to Drawings for complete description of designated fire alarm zones. Additional zones shall be dedicated but not limited to:
 - a. Individual Air Handling Units.
 - b. Food Service Fire Extinguishing Systems.
 - c. Elevator Capture Control.

- d. Elevator Shunt Trip Control.
- e. Fire Pump System.
- f. Clean Agent Fire Suppression Systems.

2.5 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 72 and local requirements.
- B. Premises protection includes **[Insert type of building construction]** and **[Insert occupancy type]**.
- C. All fire alarm, mass notification, supervisory, and trouble system signals shall initiate the following actions:
 - 1. Identify signal condition type at the **[FACU,]** **[FPUs,]** and remote annunciator. Menuing shall allow further signal information such as location, type of device and device address.
 - 2. Record events in the system memory.
 - 3. Record events by the system printer.
 - 4. Cause the device in alarm LED indicator to flash.
- D. Refer to Control by Event Schedule shown on Drawings for fire alarm and mass notification system functionality requirements.
- E. Fire alarm signal initiation shall be by one or more of the following devices:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Automatic sprinkler system water flow.
 - 5. Fire extinguishing system operation.
 - 6. Fire standpipe system.
- F. Fire alarm signal shall initiate the following additional actions:
 - 1. Alarm notification appliances shall operate continuously in synchronization.
 - 2. Transmit an alarm signal to the remote alarm receiving station.
 - 3. Unlock electric door locks in designated egress paths.
 - 4. Release fire and smoke doors held open by magnetic door holders.
 - 5. Close smoke dampers in air ducts of system serving zone where alarm initiated through signal to the BAS system.
 - a. **STANDARD SMOKE SHUTDOWN:**
 - 1) **ONE (1) N.C. CONTACT WITHIN 3'-0" OF EACH CONTROLLER ASSOCIATED WITH A MOTOR TO BE SHUTDOWN (WITH STATUS FEEDBACK CONTACT).**
 - 2) **ONE (1) N.O. CONTACT WITHIN BASP TO SIGNAL BAS PANEL(S) CONTROLLING HVAC FAN SYSTEMS HAVING A FIRE ALARM CONTROL MODE (WITH STATUS FEEDBACK CONTACT).**
 - b. **SYSTEM WITH SMOKE CONTROL SYSTEM:**
 - 1) **ONE (1) N.C. CONTACT WITHIN 3'-0" OF EACH CONTROLLER ASSOCIATED WITH A MOTOR TO BE SHUTDOWN (WITH STATUS FEEDBACK CONTACT).**
 - 2) **ONE (1) N.O. CONTACT WITHIN BASP TO SIGNAL BAS PANEL(S) CONTROLLING HVAC FAN SYSTEMS HAVING A FIRE ALARM CONTROL MODE.**

- 3) **IF SMOKE PURGE IS SPECIFIED BY DIVISION 23, ONE (1) ADDITION N.O. CONTACT WITHIN BASP TO SIGNAL BAS PANEL(S) CONTROLLING HVAC SMOKE PURGE SYSTEMS. THIS IS ACTIVATED BY A "SMOKE PURGE" SWITCH ON THE FIRE ALARM ANNUNCIATOR WHICH ALSO SIGNALS THE BAS SYSTEM TO OVERRIDE SELECTED FAN SHUTDOWN FOR SMOKE PURGE. (ACKNOWLEDGEMENT OF SUBSEQUENT ALARMS AT THE ANNUNCIATOR MAY BE NECESSARY VIA THE SILENCE SWITCH).**

c. SYSTEM WITH ENGINEERED SMOKE SYSTEMS:

- 1) **TO BE DETERMINED ON A JOB BY JOB BASIS. BAS SYSTEM SHALL BE UL 864 CATEGORY UUKL AND NFPA 92 LISTED.**

6. Stop all supply and return fans.
7. Signal the Division 23 base building BAS System of a system alarm such that the BAS intelligence can provide proper smoke and damper control. All associated signals and monitor point contacts shall be wired to the BASP where the BAS Subcontractor will provide BAS terminations. This Division 28 function is as follows:
 - a. Signal the Division 23 base building BAS System of an alarm in the building.
 - b. Signal the Division 23 base building BAS System of an RTU or AHU unit supply or return duct detector alarm (total of six (6) units) and stair tower supply fan duct detector alarms (total of ten (10) units) such that the base building BAS intelligence can provide proper smoke control.
 - c. Shut down fans with controller fire alarm control modules (symbol FR) as shown on Drawings.
 - d. Signal the Division 23 base building BAS System to activate the atrium smoke exhaust system. This function shall only be automatically initiated by atrium smoke detectors, beam detectors and sprinkler flow switches. This function shall also be manually initiated from the GSCP.
8. Activation of local detectors associated with the following devices shall cause these devices to operate.
 - a. Smoke venting hatches.
 - b. Rolling counter doors.
 - c. Electro-magnetic door holders.
9. Activation of elevator lobby, elevator shaft, or elevator equipment room automatic detectors shall cause automatic capture of **[new] [and] [existing]** elevators within associated elevator bank[s] to return them to the main egress level and shall be initiated by a control module at the elevator controller(s). Once obtaining that level, the cab doors shall open and the elevator shall shut down. Thereafter, only selected elevators may be utilized by authorized personnel.
 - a. If the alarmed detector is on the main egress level, the elevators shall automatically be returned to a predetermined alternative level.
 - b. The alarm floor shall not be the floor of egress.
10. Automatic shutdown of elevators shall be performed on an individual elevator shaft/machine run basis which may have one or multiple elevator cabs. The function shall only be initiated by associated/dedicated elevator shaft or elevator equipment room automatic heat detectors and shall be initiated by an associated/dedicated control module at the elevator room feeder contactor.
11. Signal lighting control system(s) in the building for full brightness mode of lighting operation.
12. **[Signal all sound systems in the building for broadcast cutoff.]**

13. Automatic shut-off of the building gas service via fire alarm addressable control module at the gas service solenoid valve.
 14. Record events in the system memory.
 15. Record events by the system printer.
 16. Carbon Monoxide detector alarm shall:
 - a. Cause a supervisory signal at the FACU and shall not notify the remote alarm receiving station (municipal fire department).
 - b. Cause associated carbon monoxide sounder to sound.
 - c. **[Signal BAS system through BASP contact.]**
 - d. Cause associated LED alarm (steady) signal.
- G. General mass notification signal initiation shall be by one or more of the following devices:
1. FACU.
 2. FPU.
 3. FPC.
- H. Mass notification signal shall initiate the following actions:
1. Override and cease fire alarm notification appliances when fire alarm in a normal or alarm state.
 2. Alarm mass notification appliances shall operate continuously in synchronization.
 3. Transmit an alarm signal to the remote receiving station.
 4. Release fire and smoke doors held open by magnetic door holders.
 5. Lock electric door locks in:
 - a. **[Designated egress paths.]**
 6. Unlock electric door locks in:
 - a. **[Designated egress paths.]**
 7. Activate emergency communications control unit (ECCU).
 - a. Sound an alert (pre-signal) tone (the alert tone shall be a 1000 Hz tone pulsed to produce for rounds of 1 second on and 1/2 second off throughout the buildings **[and Outdoor Speaker array]**).
 - b. Activate the recorded message appropriate for general mass notification using a female voice and repeated three times. The alarm and communication system shall provide pre-recorded message similar to the following:
 - 1) **"Alert! This is the Mass Notification System. There is an emergency situation. Do not evacuate the building! Stay in your current location! Stay tuned for future instructions."**
 - c. Activate the prerecorded message throughout the building for the general mass notification. **[Outdoor Speaker Array(s) are not to be activated automatically.]**
 - d. Definitive pre-recorded or manual messages in reaction to specific emergencies shall be initiated manually from the ECCU similar to the following:
 - 1) **"Alert! This is the Mass Notification System. There is a potential risk along the south wall of your building. Quietly move towards the north side of the building and exit from the north stairs. Move away from the building heading north to the north parking area."**
 8. Allow FPC to initiate delivery of minimum of four pre-recorded voice message and instructions, initiate visual strobe and LED text display messages.
 9. Allow FPC to initiate messages to **[Owner selected]** notification points on the Division 25 "Integrated Event Management System."

10. Record events in the system memory.
 11. Record events by the system printer.
- I. Supervisory signal initiation shall be by one or more of the following devices or actions:
 1. Fire pump running, power failure, dead phase or phase-reversal condition.
 2. Operation of a fire-protection system valve tamper switch.
 3. Low-air pressure switch operation on dry pipe or preaction sprinkler system.
 4. Elevator contactor control voltage supervisory operation.
 5. Non-system detector alarm contact signal.
 - J. System trouble signal initiation shall be by one or more of the following devices or actions:
 1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
 2. Opening, tampering, or removal of central control equipment, alarm initiating, and supervisory signal initiating devices.
 3. Loss of primary power at the FACU.
 4. Ground or a single break in FACU internal circuits.
 5. Abnormal ac voltage at the FACU.
 6. A break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at the FACU or annunciator.
 9. Loss of connection to remote alarm receiving station.
 - K. System Trouble and Supervisory Signal Actions: Ring trouble sounder and annunciate at the FACU, FPU's, and remote annunciators. Record the event on system printer.
 - L. Bypass Control "Drill" Switches:
 1. Activation of SEPARATE auxiliary bypass control switches shall override the automatic functions selectively within the system for:
 - a. Transmission of fire alarm condition signal to the remote alarm receiving station municipal fire department.
 - b. Operation of audible alarms (but not affecting indicating alarms).
 - c. Operation of fire alarm visual alarms.
 - d. Operation of mass notification visual alarms.
 - e. Operation of mass notification audible alarms.
 - f. Operation of door release devices.
 - g. Automatic shutdown of HVAC equipment.
 - h. Automatic control of smoke dampers.
 - i. Automatic capture of elevators.
 2. Bypass control shall be overridden upon the activation of a subsequent alarm from another alarmed zone.
- 2.6 FACU
- A. General Description:
 1. Modular, power-limited design with electronic modules, UL 864 listed.
 2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting **[and allow for adjustment of sensitivity at the FACU]**.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 3. Addressable control circuits for operation of mechanical equipment.

- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACU 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 (LCD) type, **[two] [three] line[s] of [40] [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].**
- C. Circuits:
 - 1. Initiating Device Circuits: NFPA 72, Class B.
 - 2. Signaling Line Circuits: NFPA 72, Class B.
 - a. System Layout: Install no more than 20 addressable devices on each signaling line circuit complete with associated isolator module.
 - 3. Notification Appliance Circuits: NFPA 72, Class B.
 - 4. Actuation of alarm notification appliances and fire safety functions, annunciation, **[smoke control,] [elevator recall,] [and actuation of suppression systems]** shall occur within 10 seconds after the activation of an initiating device.
 - 5. Network Communications: NFPA Class A.
 - 6. Electrical monitoring for the integrity of wiring external to the FACU for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.
- D. Smoke Alarm Verification:
 - 1. Initiate audible and visible indication of an "alarm verification" signal at the FACU.
 - 2. Activate a listed and approved "alarm verification" sequence at the FACU and the detector.
 - 3. Record events by the system printer.
 - 4. Sound general alarm if the alarm is verified.
 - 5. Cancel FACU indication and system reset if the alarm is not verified.
- E. Notification Appliance Circuit: Operation shall sound in **[a temporal code 3 pattern, complying with ANSI S3.41] [60 beats per minute, march-time pattern] [120 beats per minute, march-time pattern]. [Pre-signal – 900 hertz tone pulsed to product one round of code 4 at approximately one second intervals].**
- F. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.
- G. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACU and remote annunciators, after initiating devices are restored to normal.
 - 1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 - 2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
 - 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- H. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACU and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a **[digital alarm communicator transmitter and telephone lines]** **[radio alarm transmitter]**.
- J. Emergency Communication Control Unit (ECCU): Addressable, central emergency voice/alarm communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the Emergency Communication Center adjacent to the FACU.
 - 1. Indicated 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 be UL 1711 listed.
 - 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. Program tone and message sequence selection per local codes and Owner requirements.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the FACU.
 - 2. Notification-Appliance Circuits: NFPA 72, Class A.
 - 3. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 - 4. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- K. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.
 - 1. The dial-in port shall allow remote access to the FACU for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.
- L. Primary Power: 24V DC obtained from 120V AC service and a power supply module. Initiating devices, notification appliances, signaling lines, trouble signal, **[supervisory and digital alarm communicator transmitter]** **[and]** **[digital alarm radio transmitter]** shall be powered by the 24V DC source.
 - 1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power supply module rating.
 - 2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."
 - 3. System Power Supplies: Integral system power supplies shall provide 24V DC operating and emergency power to each FACU and FPU (18 amps minimum to each panel). It is the design intent that all system power supplies to derived from network panels, and each power supply module shall have dedicated outputs and a charging circuit that will support up to 110AH batteries. Field located addressable notification appliance circuit modules or remote auxiliary power supplies will not be allowed, except where specifically shown on Drawings. The following system power supply analog values shall be available for viewing through the primary operator interface display:
 - a. Battery voltage.
 - b. Battery charger voltage and current drawing.
 - c. Main output voltage (system 24V) and current drawing.

- d. Individual NAC current draw.
 - 4. Auxiliary Power Supplies: Provide distributed network power supplies where shown. Power supplies shall communicate directly to the main Fire Alarm System via multiplexed communications to support network based synchronization, and supervision of each panel for ground fault, loss of AC power and Battery Fail. Each notification circuit served shall be individually supervised via on board circuitry.
 - M. Secondary Power: 24V DC supply system with batteries and automatic battery charger and an automatic transfer switch.
 - 1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.
 - 2. Battery and Charger Capacity: Comply with NFPA 72.
 - 3. Capacity: Per NFPA 72 and local codes.
 - N. Surge Protection:
 - 1. Install surge protection on normal ac power for the FACU and its accessories. Comply with Division 26 Section "Transient Voltage Suppression" for auxiliary panel suppressors.
 - 2. Install surge protectors recommended by FACU manufacturer. Install on all system wiring external to the building housing the FACU.
- 2.7 FPU
- A. General Description:
 - 1. Field Processing Unit (FPU) is a remote network (extender) panel to FACU with identical requirements except printer and centralized acknowledgements, drill switches and system resets required only at FACU.
 - 2. The FPUs and FACU networked with each other to interface initiation and indicating functions as a peer-to-peer, token ring topology, network connected with a physically separated loop.
 - B. FPU shall be microprocessor-based, housed in an all metal cabinet suitable for wall mounting, either flush or surface. Basic FPU size shall be sized to accommodate zoning and control functions as shown on fire alarm riser diagram plus a minimum of 25 percent spare capacity. Each FPU microprocessor, memory, and associated circuitry shall have the ability to detect losses of communications with the FACU, resulting from defects in the communications circuit wiring.
 - C. Sensing circuits from the FPU to peripheral devices shall be supervised to provide an indication of sensing circuit faults. Sensing circuit supervision shall not reduce available system monitor points. Sensing circuits shall be capable of reporting an alarm, grounds, shorts, opens or trouble conditions. FPU sensing circuits shall be capable of working with normally open (N/C), or current limited normally open contacts, for Class A wiring and operation.
 - D. FPU shall be equipped with an internal 24V DC power supply and shall function as a completely independent system in event of a communications line break with the FACU or a FACU failure. In the event of a communications or FACU failure, the local FPU shall receive and process monitor point inputs and shall initiate the appropriate control point actions. The local fire alarm annunciator shall function normally for all local zones.
 - 1. If FPU to FACU communications failure, the FPU shall initiate audible alarms through its own redundant tone generators. The tone generators shall be sized for minimum 25 percent spare capacity above the sum of all devices at maximum tap settings.
 - 2. Voice/Tone speaker circuits shall have central redundant preamplifiers, amplifiers, and pre-recorded messaging and tone generators, located at the FACU, zoned through distributed amplifiers with addressable outputs at the FPU.

E. Other Control Features/Functions Include:

1. Interface alarm inputs and control circuits outputs and communicate changes in operating status to the FACU.
2. All industry fire alarm systems currently use BACnet protocol.
3. Communication between the FPU and the FACU shall incorporate a BACnet Local Operating Network (LON) for easy wiring.
4. The LON shall provide the interface for the Network Input/Output Nodes. The LON shall be a transformer isolated twisted pair network operating a 78.5K baud. Without any additional power boosters, the LON shall be capable of wiring runs up to 2000 meters in length. Wiring runs in excess of 2000 meters shall be accomplished with the use of signal boosters.
5. Provide continuous supervision of alarm input circuits and report alarm, opens, or ground conditions.
6. The FPU shall operate at 120V AC input with sufficient capacity to operate all alarm inputs and control circuit outputs. The FPU shall be provided with 25 percent spare capacity points.
7. Batteries shall provide operating power to comply with NFPA 72. Batteries and charging circuitry shall be monitored and alarmed for battery failure (low charge or disconnected) or battery charger failure (high charge or system voltage failure).
8. FPU modules shall be card rack mounted, easily expanded, and contain sufficient capacity for all input and output functions as shown on Drawings.
9. Control circuit output relays shall be multiple, convertible contacts, 24V DC, 5A rating. Outputs shall be provided and coordinated for door release, HVAC shutdown, smoke dampers, and auxiliary devices as shown on Drawings.
10. The FPU panel shall be interfaced with remote annunciator and FACU.

2.8 FATC

- A. Fire Alarm Terminal Cabinets (FATC), as required, shall be surface mounted, labeled with "FIRE ALARM" nameplate, and shall contain screw type terminal strips as required for the wiring of the system as shown on Drawings. Provide cabinet size for amount of terminations and equipment modules required, including 10 percent spare capacity flush or surface mounted as shown on Drawings.
1. Provide lockable FATC at ECC location for final as-built documents. ECC shall be located at Campus Police location for monitoring.

2.9 ECC

- A. The ECC shall be in a 2-hour rated room consisting of:
1. A networked **[touch screen]** fire alarm PC (FPC) and printer reporting all alarms and conditions.
 2. FPC wall mount auxiliary monitor.
 3. FACU.
 4. ECCU.
 5. Building (Facility) graphic annunciator.
 6. FATC with final as-built documents.
 7. **[GSCP.]**

2.10 Fire Alarm Personal Computer (FPC)

- A. Manufacturer's standard **[touch screen]** fire alarm PC, complete with printer and dedicated manufacturer's standard UPS. UPS shall be Type O, Class 24, Level 1. **[Unit shall be listed under UL864 as a primary operator's workstation].**

- B. To eliminate confusion during an alarm situation, the screen shall have dedicated areas for the following functions:
 - 1. Alarm and returns to normal.
 - 2. Commands, reports, and programming.
 - 3. Time, day, and date.
- C. Full English language shall be used throughout to describe system activity and instructions. Full English language descriptors defining system points shall be 100 percent field programmable by factory trained personnel, alterable and user definable to accurately describe building areas.
- D. Alarm and other changes of status shall be displayed in the screen area reserved for this information. Upon receipt of alarm, an audible alarm shall sound and the condition and point type shall flash until acknowledged by the operator. Returns to normal shall also be annunciated and shall require operator acknowledgment. The following information shall be provided in English:
 - 1. Condition of device (alarm, trouble, or supervisory).
 - 2. Type of device (manual pull, waterflow, etc.).
 - 3. Location of device plus numerical system address.
- E. The system shall have multiple levels of priority for displaying alarms to conform with UL 864. Priority levels shall be as follows:
 - 1. Level 1 – Mass Notification.
 - 2. Level 2 – Fire Alarms.
 - 3. Level 3 – Supervisory Alarms.
 - 4. Level 4 – Trouble Signals.
- F. The system shall be provided with memory so that no alarm shall be lost. A highlighted message shall advise the operator when unacknowledged alarms are in the system.
- G. Multiple levels of access shall be provided for operators and supervisors via user-defined passwords. The following functions shall be provided for each level:
 - 1. Operator Level Access Functions:
 - a. Display system directory, definable by device.
 - b. Display status of an individual device.
 - c. Manual command (alarm device with an associated command shall use the same system address for both functions).
 - d. Report generation, definable by device, output on either the FPC or printer, as desired by the operator.
 - e. Activate building notification appliances.
 - 2. Supervisory Level Access Functions:
 - a. Reset time and date.
 - b. Enable or disable event initiated programs, printouts, and initiators.
 - c. Enable or disable individual devices and system components.
- H. The above supervisory level functions shall not require computer programming skills. Changes to system programs shall be recorded on the printer and maintained in the control panel as a trouble condition.

2.11 FPC WALL MOUNT AUXILIARY MONITOR

- A. Minimum 42 inch diagonal **[touch screen]** flat panel color monitor with wall mount **[pivot type]** bracket and balanced cabling from FPC.

2.12 REMOTE ANNUNCIATOR

- A. Description: Duplicate annunciator functions of the FACU for alarm, supervisory, and trouble indications. Also duplicate manual switching and menuing functions of the FACU, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush or surface mounted cabinet, as shown on Drawings.
 - 2. NEMA 250, Class 1.
- B. Display Type and Functional Performance: Alphanumeric LCD display same as the FACU. Controls with associated LEDs permit acknowledging, menuing silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACU. Size for 25 percent future expansion.

2.13 GSCP

- A. The Graphic Smoke Control Panel (GSCP) shall be designed as a graphic schematic elevation representation of the building, indicating each floor, smoke zones, major ducts, smoke dampers, air flow direction, relays, and relative locations of the equipment controlled by H-O-A (Hand-Off-Auto) 3-position switches. Panel construction shall be per "Graphic Annunciator" specification.
- B. Fans, dampers, and other operating equipment in normal status shall be indicated by a GREEN LED. Fans, dampers, and other operating equipment in off or closed status shall be indicated by a RED LED. Fans, dampers, and other operating equipment in fault status shall be indicated by a YELLOW LED.
- C. Provide H-O-A switches labeled "ON-AUTO-OFF" on the GSCP to permit firefighters manual control of each individual smoke control fan or air handling units. **[Provide H-O-A switches labeled "OPEN-AUTO-CLOSE" on the annunciator for each individual smoke control damper.]**
- D. Locate H-O-A switches and LEDs on the GSCP graphic adjacent to their associated smoke control equipment.
- E. Provide at least one white LED on the GSCP to indicated system in normal status.
- F. Provide a toggle or push button switch to test the LEDs mounted on the unit. The test switch does not require key operation.
- G. Provide an H-O-A switch labeled "OPEN-AUTO-LOCK" on the annunciator for each stairway to permit firefighters manual control of stairway door locks in accordance with local codes.
- H. In the normal switch position, the fans, air handling units, or dampers operate automatically as controlled by the building automation/temperature control system. Automatic controls can be overridden with the H-O-A switches provided on the GSCP. The operation of the H-O-A switches shall permit manual control and override of any conflicting signal from the building automation/temperature control system or any other system.
- I. All LEDs for the status monitoring of the equipment shall be wired to show the actual status, "On" or "Off" of the controlled items via signals from a dry set of contacts generated from the building automation system (BAS). H-O-A switches shall be provided for control of fans at the FCC as indicated below:
 - 1. All supply and return air handling units that may cause recirculation of smoke.
 - 2. Each stairwell pressurization fan.
 - 3. Supply and exhaust fans.
 - 4. Each elevator shaft pressurization fan.
 - 5. Each atrium exhaust fan.
 - 6. Each smoke exhaust fan.

- J. The following units shall be controlled with H-O-A switches:
 - 1. All supply air handling units.
 - 2. All return fans.
 - 3. All exhaust air handling units.
 - 4. All exhaust fans.
- K. In addition to the H-O-A switches required, furnish and install 10 spare each H-O-A switches for future use. Leave switches in cabinet enclosure.

2.14 BASP

- A. Furnish and install BAS Interface Panel (BASP) consisting of independent FATC with separate termination strips for all fire alarm control and monitor points jumpered to separate terminations for all BAS monitor and control points. The BASP shall be labeled as "Fire Alarm BAS Interface Panel" with 2-inch high white lettering on a red background.
- B. Each conductor entering the BASP from the fire alarm system shall be appropriately and clearly identified and coordinated with the BAS subcontractor to ensure proper interface.
- C. Control Signals:
 - 1. Wiring from the fire alarm systems to the BAS interface panel shall be provided for the following alarm and trouble signals generated by the fire alarm system:
 - a. General alarm.
 - b. General trouble.
 - c. Each duct smoke detector in alarm.
 - 2. Wiring from the GSCP H-O-A switches in the fire command center to the BASP shall be provided to allow for the following operation:
 - a. When the H-O-A is in the automatic position, the controlled equipment shall operate as directed by the BAS system.
 - b. When the H-O-A switch is in the "ON" position, a signal shall be sent to the BAS system to bypass all other control of the selected equipment and turn the controlled equipment on. The controlled equipment shall continue to operate until the H-O-A switch is restored to the "AUTOMATIC" or "OFF" position.
 - c. When the H-O-A switch is in the "OFF" position, a signal shall be sent to the BAS system to bypass all other control of the selected equipment and turn the controlled equipment off. The controlled equipment shall remain in the off condition until the H-O-A switch is restored to the "AUTOMATIC" or "ON" position.
 - 3. HVAC air handling units, consisting of supply and return fans, shall have separate H-O-A switches for each fan.
 - 4. HVAC air handling units (such as supply air handling units or exhaust air handling units) consisting of multiple fans, in parallel, in a common unit, shall have one H-O-A switch for the unit to control both fans simultaneously.

D. Monitor Signals:

1. Wiring from the BASP (originating at the BAS system) shall be provided for the following monitor signals:
 - a. For each piece of equipment controlled by an H-O-A switch, the BAS system shall determine the actual status, ON or OFF, of the equipment. These status signals shall be used to illuminate the proper LED at each H-O-A switch.

E. Be responsible to coordinate with the BAS subcontractor and fire alarm manufacturer the proper rating (amperage and voltage) and contact types between the fire alarm system and the BAS system to accomplish the above.

1. Provide 10 spare sets of contacts to monitor BAS prints and 10 spare sets of contacts to signal the BAS of fire alarm status conditions.

F. Provide all wiring between the fire alarm system and the BASP. All wiring between the BAS system and the BASP will be by the BAS subcontractor.

2.15 MANUAL PULL STATIONS

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mount on recessed outlet box; if shown on Drawings as surface mounted, provide manufacturer's surface back box.

1. 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 the FACU.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: When shown on Drawings, provide 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. Provide Stopper II Guards for all manual stations in public areas.
4. Weatherproof Protective Shield: When shown on Drawings, provide factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Weatherproof devices shall be non-addressable and rated for the intended equipment; monitored by an addressable module located in a conditioned space.

2.16 SYSTEM SMOKE DETECTORS

A. General Description:

1. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACU.
2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
3. Remote Control: Detectors shall be analog-addressable type, individually monitored at the FACU for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACU.
 - a. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Back-up Sensor: Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACU to operate at 135 or 155 deg F (68 deg C) deg F (57 deg C).

3. Detector Photoelectric Sensitivity: Between 0.2 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
 4. UL 268 listed, operating at 24V DC, nominal.
 5. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
 6. Local Sonalert base audible alarm type as shown on Drawings containing the following:
 - a. Piezoelectric sounder rated at 88 dBA at 10 feet (3 m) according to UL 464.
 7. Integral Visual-Indicating Light: Alarm/power LED type.
- C. Beam Type Smoke Detector:
1. Each detector shall consist of a separate transmitter and receiver, and shall have the following features:
 - a. UL 268 listed, operating at 24V DC, nominal.
 - b. Adjustable Sensitivity: At least six sensitivity levels, settable at the receiver, measured as percent of obscuration.
 - c. Two selectable alarm delay settings, allowing each to be associated with a corresponding sensitivity.
 - d. Trouble signal delay, fixed at 20 seconds.
 2. Beam Type Smoke Detector Status Station:
 - a. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status with remote indicator panels.
 - b. Flush wall mounted in finished areas and surface wall or group mounted in equipment rooms.
- D. Air Sampling Smoke Detector System: Includes air sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit. Utilize in MDF room.
1. UL 268 and UL S5198 listed, operating at 24V DC, nominal.
 2. Pipe Network: 3/4-inch PVC smooth bore tubing connects control unit with designated sampling holes UL 1887 listed.
 - a. Tubing shall be identified as air sampling smoke detector pipe (or similar wording) along its entire length at regulator intervals not exceeding the manufacturer's recommendation or that of local codes and standards.
 - b. Far end of each trunk or branch tube shall be fitted with an end cap and drilled with a hole appropriately sized to achieve the performance specified and as calculated by the system design.
 - c. Provide sampling holes of 5/64 inch separated by less than the maximum distance allowable for conventional point detectors as specified in the local code or standard. Intervals may vary according to manufacturer's calculations.
 - 1) Each sampling point shall be identified in accordance with Codes or Standards.
 - 2) Consideration shall be given to the manufacturers' recommendations and standards in relation to the number of sampling points and the distance of the sampling points from the ceiling or roof structure and forced ventilation systems.
 - d. Provide fittings suitable for installation including sports, angles, tees, elbows, unions, caps, etc.
 - 1) Provide unions at each tube six inches from detector enclosure to allow future tubing cleaning (blowing out).

- e. Provide labels on tubing at each sampling point to deter painting of that point per NFPA 72.
 - 3. Air Sampling Smoke System Enclosure:
 - a. Smoke Detector: Particle counting type with continuous laser beam. Sensitivity adjustable to a minimum of three preset values.
 - b. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg (12.5 Pa) at all sampling ports.
 - c. Control Unit: Single or multi-zone unit as shown on Drawings. Provides same system power supply, supervision, and alarm features as specified for the central FACU plus separate trouble indication for airflow and detector problems.
 - d. Signals to the Central FACU: Any type of local system trouble is reported to the central FACU as a composite "trouble" signal. Alarms on each system zone are individually reported to the central FACU as separately identified zones.
 - E. Duct Smoke Detector:
 - 1. Photoelectric Smoke Detectors:
 - a. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - b. Detector Sensitivity: Between 0.2 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
 - c. UL 268A listed, operating at 24V DC, nominal.
 - d. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACU.
 - e. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
 - f. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - g. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station as shown on Drawings.
 - h. Remote Control: Detectors shall be analog-addressable type, individually monitored at the FACU for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACU.
 - i. Each sensor shall have multiple levels of detection sensitivity.
 - j. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
 - k. Locate detectors at ductwork on roof where accessible.
 - 2. Remote Duct Smoke Detector Test Station:
 - a. Alarm/power LED on faceplate.
 - b. Flush wall mounted in finished areas and surface wall mounted or group wall mounted in equipment rooms.
 - c. White lettering on red nameplate identifying associated detector(s).
- 2.17 SYSTEM CARBON MONOXIDE (CO) DETECTOR
- A. General Description:
 - 1. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACU.
 - 2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal.

3. Integrate audio and visual requirements with fire alarm notification system.
4. Remote Control: Detectors shall be analog-addressable type, individually monitored at the FACU for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACU.

- a. Provide multiple levels of detection sensitivity for each sensor.

B. Carbon Monoxide Detectors:

1. UL 268 listed, operating at 24V DC, nominal.
2. Sensor: UL 2075 listed, programmable for carbon monoxide level concentration, base or detector mounted.
3. Additional removable system sensors for mounting on base:
 - a. Analog-addressable photoelectric smoke detector sensing.
 - b. Fixed temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACU to operate at 135 or 155 deg F.
4. Integral Visual Indicating Light: Alarm/power LED type.

2.18 HEAT DETECTORS

- A. General: UL 521 listed selectable as fixed temperature or combination fixed/rate-of-rise operation as described herein. Heat detectors shall also be programmed as a low temperature utility sensor when ambient temperature drops below 40 degrees F. Heat detectors shall be of the bi-metal restorable type.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature and/or rate-of-rise of temperature that exceeds 15 degrees F (8 degrees C) or 20 degrees F (11 degrees C) selectable at the FACU per minute as shown on Drawings.
 1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACU.
- C. Heat Detector, Fixed Temperature Type: Actuated by temperature that exceeds a fixed temperature selectable as 135 degrees F (57.2 degrees C) or 155 degrees F (68 degrees C) as shown on Drawings.
 1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACU.
- D. Where ambient conditions preclude the use of addressable devices, equivalent conventional devices, rated for the environment shall be used. Each device shall be monitored by a dedicated addressable module located in a conditioned space.

2.19 FIRE ALARM NOTIFICATION APPLIANCES

- A. Description: Equipped for mounting generally as shown on Drawings and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
- B. Audibility and Intelligibility Requirements:
 1. Suitable per NFPA 72 and local requirements[**for the ADS zones scheduled on Drawings**].

2. Be responsible to meet requirements using manufacturer specific notification appliances whose tap settings are generally set at the lower (1/2 watt) of their associated range and main power supplies and amplifiers with 25 percent minimum spare capacity above sum of all devices at maximum tap settings. Contract Drawing layouts depict generic industry solution approaches. Add notification appliances at no cost to Owner to meet these requirements. Submit design compliance per Pre-installation Shop Drawing Submittal requirements.
3. Design compliance to acknowledge the following minimum acoustical layout criteria:
 - a. Published anticipated average ambient room sound levels.
 - b. Loss of dBA for barriers:
 - 1) Stud/Drywall Walls: 35-50
 - 2) Doors: 15-20
 - 3) Drywall: 15-20
 - 4) Wall Coverings: 3-5
 - c. Space acoustical characteristics.
 - d. Speakers set at lower tap settings generally provide better intelligibility and more uniform sound levels.
 - e. Speakers in equipment rooms shall be set at minimum 2 watt tap setting.
 - f. Maximum occupant distance from a speaker is 50 feet.
- C. Voice/Tone Speakers:
 1. UL 1480 listed.
 2. General Type Low-Range Units: Rated 1 to 2 W.
 3. Horn Type High-Range Units: Rated 2 to 15 W.
 4. Mounting: Flush, semi-recessed, or surface mounted; bidirectional as shown on Drawings. Flush ceiling speakers shall have round white grill. Surface ceiling speakers shall have backbox sized larger than grill.
 5. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.
- D. Exit Directional Evacuation Speakers:
 1. UL listed.
 2. Adjustable Power Rating: 1/4 to 4 W.
 3. Mounting: Semi-recessed wall mounted.
 4. Matching Transformers: Tap range matched to the exit path and acoustical environment. Submit manufacturer's selected ratings with shop drawings for each location.
 5. Disable/Enable control contacts.
- E. Visible Alarm Devices: System synchronized xenon strobe lights listed under UL 1971, with clear polycarbonate lens mounted on faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens for fire alarm notification only. The word "ALERT" is engraved in minimum 1-inch- (25-mm-) high letters on the lens for notification devices also used for carbon monoxide notification.
 1. Rated Light Output: As shown on Drawings.
 2. Strobe Leads: Factory connected to screw terminals.
 3. Synchronization of strobes shall be accomplished via software programming systems that required field modules and synchronization circuits will be not considered acceptable.
- F. Notification Appliance Circuit (NAC) Extender Panel: The NAC extender panel shall function as a wiring termination and data collection point on each floor.
 1. Provide additional notification appliance circuit capacity and synchronization for new **[and existing]** visible alarm devices. Size panel as required.

2. The NAC extender panel may be mounted close to the host FACU [or] [FPU] or can be remotely located and shall connect to the host panel via a communications channel. Each output NAC can be individually controlled for general alarm or selective area notification as required by the area and function.
3. Alarms from the host fire panel shall signal the NAC power extender panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the host panel.
4. Provide additional addressable signal, synchronization and relay modules to meet Boston Fire Department's high rise evacuation requirements. Refer to Paragraph 1.4E for additional requirements.

2.20 MASS NOTIFICATION APPLIANCES

- A. Description: Equipped for mounting generally as shown on Drawings and with screw terminals for system connections.
 1. Combination Devices:
 - a. Factory-integrated audible and visible devices in a single-mounting assembly.
 - b. Factory-integrated audible and visible fire/mass notification devices in a single-mounting assembly.
- B. Audibility Requirements:
 1. Suitable per NFPA 72 and local requirements.
 2. Be responsible to meet requirements using notification appliances whose tap settings are generally set at the lower (1/2 watt) of their associated range and main power supplies and amplifiers with 25 percent minimum spare capacity above sum of all devices at maximum tap settings. Add appliances at no cost to Owner to meet these requirements. Submit design compliance per Pre-installation Shop Drawing Submittal requirements.
 3. Design compliance to acknowledge the following minimum acoustical layout criteria:
 - a. Published anticipated room sound levels.
 - b. Loss of dBA for barriers:
 - 1) Stud/Drywall Walls: 35-50
 - 2) Doors: 15-20
 - 3) Drywall: 15-20
 - 4) Wall Coverings: 3-5
 - c. Space acoustical characteristics.
 - d. Speakers set at lower tap settings generally provide better intelligibility and more uniform sound levels.
 - e. Speakers in equipment rooms shall be set at minimum 2 watt tap setting.
 - f. Maximum occupant distance from a speaker is 50 feet.
 - g. Speaker intelligibility requirements per local authority.
- C. Voice/Tone Speakers: See fire alarm notification appliances.
- D. Visible Alarm Devices: System synchronized xenon strobe lights listed under UL 1971, with amber polycarbonate lens mounted on faceplate. The word "ALERT" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 1. Rated Light Output: As shown on Drawings.
 2. Strobe Leads: Factory connected to screw terminals.
 3. Synchronization of strobes shall be accomplished via software programming systems that required field modules and synchronization circuits will be not considered acceptable.

- E. Notification Appliance Circuit (NAC) Extender Panel: The NAC extender panel shall function as a wiring termination and data collection point on each floor.
1. Provide additional notification appliance circuit capacity and synchronization for new[**and existing**] visible alarm devices. Size panel as required.
 2. The NAC extender panel may be mounted close to the host FACU [or] [FPU] or can be remotely located and shall connect to the host panel via a communications channel. Each output NAC can be individually controlled for general alarm or selective area notification as required by the area and function.
 3. Alarms from the host fire panel shall signal the NAC power extender panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the host panel.
 4. Provide additional addressable signal, synchronization and relay modules to meet Boston Fire Department's high rise evacuation requirements. Refer to Paragraph 1.4E for additional requirements
- F. LED Text Display:
1. Enclosure: Maximum 16 inches long by 6 inches high by 3 inches deep.
 2. Mounting: Semi-flush wall or surface ceiling.
 3. Display: Two lines of messaging minimum 20 LED characters per line. Text shall be minimum 1/2 inch high readable up to 20 feet away.
 - a. During non-emergency periods, date and time shall be displayed.
 - b. "EVACUATE" and "ANNOUNCEMENT" system displays for those system initiations shall have minimum 4 inch high text.
 4. Firmware: 32K character memory and RS232 or RS485 serial interface.
- G. Outdoor Speaker Array:
1. General: 16-32 weather-resistant, high efficiency, aluminum horns each with 100W drivers as shown on Drawings.
 2. Coverage: Omni-directional or directional as shown on Drawings.
 3. Mounting: Pole mast sized for the installation with 120 mph winds.
 4. Amplifier Cabinet:
 - a. Class D high efficiency amplifiers.
 - b. 1600W-3200W with 120 volts AC power supply.
 - c. THD less than 0.2 percent from 80 Hz to 20 KHz with acoustical performance and intelligibility features complying with NFPA 72.
 - d. Pole mast mounted in NEMA 4 cabinet.
 - e. Receive priority message input from EVAC system.
 5. Environmental:
 - a. Operating Temperature: -25 to +60 degrees C or -13 to 140 degrees F.
 - b. Lighting Protection: On mains and speaker lines.

2.21 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

- A. Dedicated, two-way, supervised, telephone voice communication links between the FACU[, **the Emergency Communication Center,**] and remote firefighters' fire phone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:
1. Common-talk type for firefighter use only.
 2. Selective-talk type for use by firefighters.

3. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously.
4. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is activated, it causes audible signal to sound and high-intensity lamp to flash.
5. Fire phone selector panel controls simultaneous operation of telephones in selected zones and permits up to six phones to be operated simultaneously. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
6. Provide **graphic** display to indicate location of caller.
7. Fire Phone: Flush mounted cabinet, factory-standard red finish, with handset.
 - a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Emergency Phone."
 - b. With "break-glass" type door access lock.
8. Fire Phone Jack Station: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Emergency Phone."
9. Handsets: Provide[**push-to-talk**] type sets. Provide one handset stored in a cabinet adjacent to the FACU.

2.22 MAGNETIC DOOR HOLDERS

- A. Supplied by Division 08, wired by Division 28.
- B. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.
 1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
 2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
 3. Rating: 24V DC held momentary under loss of primary power.
 4. Material and Finish: Match door hardware.

2.23 WATERFLOW ALARM, WATERFLOW SUPERVISORY TAMPER, AND DRY PIPE PRESSURE SWITCHES

- A. Supplied by Division 21, wired by Division 28.

2.24 ADDRESSABLE RELAY

- A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for hard-wired applications with auxiliary contacts such as non-system detectors, waterflow switches, tamper switches.
 1. Integral Relay: Provides a direct control signal for hard-wired applications with input contacts such as elevator recall, shunt trip, door release, smoke hatch release, fan shutdown, etc.
 - a. Minimum relay quantities for door releases shall be by floor (per FPU) to control all door releases in the area.

2.25 ISOLATOR MODULE

- A. Description:
 1. The isolator module shall detect and isolate a short-circuited segment of a fault-tolerant loop.
 2. The module shall automatically determine a return to normal condition of the loop and restore the isolated segment.

3. Modules shall be placed every 20 signaling devices or by fire zone to limit the number lost in the event of a short-circuit. Locate securely in accessible ceiling space. Provide identification nameplate per Division 26 Section "Electrical Identification."

2.26 ADDRESSABLE RELAY AND ISOLATOR MODULES CABINET

- A. Addressable and isolator modules, dependent on location, may, at Division 28 discretion, be mounted in cabinets in mechanical/electrical rooms for interaction/connection with room devices or be mounted as an integral part of the FPU cabinets.

2.27 RADIO ALARM TRANSMITTER

- A. Listed and labeled according to NFPA 1221. Comply with 47 CFR 90.
- B. Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; and ready for installation and operation.
 1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
 2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
 3. Normal Power Input: 120V AC.
 4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 5. Antenna: Omni-directional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph (160 km/h) with a gust factor of 1.3 without failure.
 6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
 7. Antenna-Cable Connectors: Weatherproof.
 8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
- C. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACU or from its own internal sensors or controls, and automatically transmits signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages correspond to standard designations for the fire-reporting system to which the signal is being transmitted and include separately designated messages in response to the following events or conditions:
 1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
 2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
 3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
 4. Local Fire Alarm System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
 5. Local Fire Alarm System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
 6. Local Alarm System Supervisory Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

2.28 WIRE GUARDS FOR PHYSICAL PROTECTION

- A. Description: Welded wire mesh of size and shape for the smoke detector, audible device, visual devices, or other device requiring protection as shown on Drawings.
 - 1. Construction and Finish: Per Division 26 Section "Wiring Devices."

2.29 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
 - 1. Limit circuit voltage drop to 10 percent maximum.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.
- C. Circuit Integrity Cable: Twisted [**shielded**] pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.
 - 1. Notification appliance circuits passing through a separate fire zone shall be 2-hour rated per UL 2196.
 - 2. Backbone communication circuits between FACU and FPU shall be 2-hour rated per UL 2196.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 18 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
 - 3. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

PART 3 - EXECUTION

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SECTION 284800 - EMERGENCY RESPONSE SYSTEMS

PART 1 - PRODUCTS

1.1 EMERGENCY RESPONDER COMMUNICATIONS ENHANCEMENT SYSTEMS

- A. Description: This category includes in-building ERCES equipment to improve emergency wireless communication. This FCC-certified enhancement system is inclusive of BDA, transmission lines, cables, power supplies, antennas, and other ancillary equipment that allows radio signals to pass to and from interior of structure for facilitating radio communications using PES radio frequencies.
- B. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 - b. Unless otherwise indicated in Contract Documents, products must comply with NFPA 1, NFPA 70, NFPA 72, NFPA 1221, NFPA 101, ICC IBC, ICC IFC, and local regulations enforced by authorities having jurisdiction.
 - 2. Capable of facilitating frequencies in the 450-512MHz T-Band range per all requirements of the AHJ.
- C. Performance Sequence
 - 1. The installation of this system shall be coordinated with the building project timeline so that its installation and operation can be implemented based on the need for the system based on testing of the exterior signal source after the building is fully enclosed and all interior walls have been constructed.
 - 2. The installer shall notify the construction manager/general contractor of the proper timeframe to test the facility to determine if there is a reliable signal source within the building that would verify that it is acceptable to eliminate the installation of the emergency responder radio system. The contractor shall work with the local fire department to verify this timeframe.
 - 3. Prior to the testing date determined, the contractor shall provide all necessary coordination and preparation work to ensure that the system can be installed without any rework or reconfiguration of the system or other systems for its intended operation. Preliminary shop drawings and testing criteria information shall be provided in a timely manner so that approvals can be provided.
 - 4. At such time, the contractor shall complete the testing scenario and provide complete testing data to verify that the signal is available and strong enough to meet the testing criteria outlined in this specification or as required by the Pasadena, CA or other local codes or ordinances.
 - 5. If testing scenario fails or is otherwise incomplete, continue with installation of the system as noted in these documents.
 - 6. If testing scenario passes, and it can be agreed to by all parties that the exterior signal source can penetrate all areas of the building effectively and it will pass the Pasadena, CA strict guidelines upon building completion, installation shall discontinue and testing criteria and results shall be turned over to the local fire department for approval. The fire department shall perform a test to match/verify signal values and provide a determination that the test is accurate, and that system installation is not necessary. If the fire department determines the test is not accurate or that the signal value margins are not acceptable, the emergency responder radio system installation shall proceed.

7. Upon building completion, a final verification test shall be completed prior to the certification of occupancy of the building. This test shall be per the requirements of this specification and test results shall be provided to the fire department for subsequent verification testing and approval.
8. If system installation is not required, a credit shall be provided for all work that is not performed.

D. Functional Performance:

1. A minimum signal strength of -95 dBm received at the Fire Department System from 95 percent of the area of each floor of the building.
2. Fire egress stairwells and fire control center must have 99 percent coverage for public safety channels.
3. Calculation shall be provided for each supported service to verify the signal levels required to maintain the specified reliability and coverage objectives.
4. Verify with the local fire department the correct frequency range to be supported prior to design and installation.

E. In-Building ERCES Bi-Directional Amplifiers

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. Advanced RF Technologies, Inc. (ADRF).
 - b. Gamewell-FCI; Honeywell International, Inc.
 - c. Notifier; Honeywell International, Inc.
 - d. Radio Solutions Inc. (RSI).
 - e. Silent Knight; Honeywell International, Inc.
2. Listing Criteria: UL CCN UTMH; including UL 2524 and NFPA 1221.
3. Options:
 - a. Primary Power Supply: [120 V(ac)
 - b. Secondary Power Supply: 24 V(dc) supply system including batteries, automatic float-charge battery charger, and automatic transfer switch.
 - c. Supervision: Auxiliary contacts for remote status supervision by protected premises fire-alarm system.
 - 1) Signal booster failure.
 - 2) Antenna malfunction.
 - 3) Loss of primary power.
 - 4) Low battery voltage.
 - 5) Battery charger failure.

F. Backup Power

1. 24-hour backup power is required. All DAS electronics shall be provided with battery backup.
2. The battery system shall automatically charge in the presence of external power input.

G. In-Building ERCES Distributed Antennas

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. Fractal Antenna Systems, Inc.
 - b. Laird Connectivity; Advent International.
 - c. Approved Equal

2. Options:
 - a. Type: Wide-band Omni directional and multi-band.
 - b. Mounting: Low-profile ceiling mount.
- H. In-Building ERCES Donor Antennas
 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. Fractal Antenna Systems, Inc.
 - b. Laird Connectivity; Advent International.
 - c. Approved Equal
 2. Options:
 - a. Configuration: Factory assembled and tuned directional UHF Yagi antenna.
 - b. Mounting: Stainless steel mounting hardware.
 - c. Finish: Welded or seamless corrosion-resistant aluminum construction.
 - d. Wind Velocity Rating: Comply with minimum ICC IBC requirements
- I. RF Antenna Cable Couplers and Splitters
 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. CommScope, Inc.
 - b. Mini-Circuits; Scientific Components Corp.
 2. Options:
 - a. Configuration: Nominal 0.5 inch13 mm, 50 Ω , N-Type, weatherproof, medium-size, RF couplers and splitters for coaxial cables.
 - b. Bandwidth: As required by in-building emergency radio enhancement system performance requirements
 - c. Gain (dB) Rating: As required by in-building emergency radio enhancement system performance requirements
- J. Remote Indicator Panel
 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. Space Age Electronics, Inc.
 2. Options:
 - a. Primary Power Supply: 120 V(ac)240 V(ac).
 - b. Secondary Power Supply: 24 V(dc) supply system including batteries, automatic float-charge battery charger, and automatic transfer switch.
 - c. Configuration: Zone indicator panel with LED indicators, and switches for lamp test and alarm silence.
 - d. LED Indicators: Green indicator for primary power in normal state; red indicators for each individual fault status required to be indicated by authorities having jurisdiction.
 - e. Enclosure: 16-gauge steel with factory-applied red enamel finish.

1.2 TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS FOR RESCUE ASSISTANCE

- A. Description: This category includes equipment for providing two-way emergency voice communication for areas of refuge, stairway landings, elevator landings, and occupant evacuation elevator lobbies in accordance with NFPA 72.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Rath Communications or comparable product by one of the following:
 - 1. Talkaphone
 - 2. Cornell Communications
 - 3. Approved Equal
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 - b. Unless otherwise indicated in Contract Documents, products must comply with NFPA 1, NFPA 70, NFPA 72, NFPA 101, ICC IBC, ICC IFB, and local regulations enforced by authorities having jurisdiction.
 - 2. Listing Criteria: UL 2525 and NFPA 72.
- D. General Characteristics:
 - 1. Master Control Station: Mount in constantly attended location to provide power, supervision, and control for two-way emergency communications systems for rescue assistance.
 - a. The master annunciator panel shall have a capacity for 12 zones, mounted at the Main Fire Department Entrance to the building (refer to Drawings). Verify location with the Local Fire Department and the Architect prior to installation
 - 1) The master station shall have features that make it possible for the operator to acknowledge an emergency call. Pressing an individual area "Talk" button at the master shall illuminate a "Help Coming" LED at the area station and shut off the associated alarm (sonalert). The previously illuminated "Help Requested" light shall be extinguished and an open voice line established between master and area station. Conversation at the area station shall be "hands-free" (requiring the use of no controls or switches once the "Push for Help" button has been activated).
 - 2) An indicator shall be provided on the control panel for each of the following functions: system power on, system trouble light, and each rescue area.
 - 3) With the system in standby mode, two (2) illuminated LEDs shall indicate the system is operating properly.
 - 4) The master station shall have a common audible alarm and separate visual indicators for each Area of Rescue Assistance Station to signal "Help Requested."
 - 5) The control panel is to have a separate trouble LED for each Area Station to indicate if there is a break or short in the wires.
 - 6) An alternate action switch with internal LED indicator shall be included for each zone. A yellow LED light on the zone switch shall illuminate and the alarm shall emit a repeating sound if the supervised wiring is faulty.

- 7) An audible alarm shall be mounted on the Annunciator Panel which will emit a minimum sound level of 90 dB at 30 cm when a remote station calls. Depressing the zone switch will answer a zone call and open the intercom line to the zone. The push to talk switch will initiate voice communication to the zone.
 - 8) The front panel shall have silk-screened zone designations and operating directions as well as zone designation strips.
 - b. Power Supply: 24 V(dc) supply system including batteries, automatic float-charge battery charger, and automatic transfer switch.
 - c. Communicate between master control station handset and remote communications stations.
 - d. Annunciate visual and audible signal at master control station when remote telephone handset is lifted from cradle or when phone is plugged into designated remote jack.
 - e. Silence audible signal when master control station handset is removed and remote telephone handset is acknowledged.
 - f. Display identification for location of remote communications stations in building.
2. Remote Communications Stations: Single-gang or double-gang, stainless steel-plate mounted station with hands-free, two-way communication.
 - a. The remote call station shall be vandal resistant and have one momentary switch with LED and loudspeaker.
 - b. The station shall have hands-free voice communication with the annunciator.
 - c. Operation instructions, consistent with ADA requirements for legibility in type, size, and style shall be engraved onto the cover plate for each area station.
 - d. The station shall be flush wall mounted on a 2-gang stainless steel plate with large push button.
 - e. Unit shall be powered from the Master Station with separate power source for the amplifier.
 - f. Each area station is to have "ultra-bright" LED indicator lights (one red LED for "Help Requested" and one red LED for "Help Coming") and shall generate an easily audible alarm tone.
 - g. The push button on each area station shall be heavy duty stainless steel, vandal-resistant, 3 inches in diameter, domed button with LED light. It shall be easy to push and shall not be obscured by other parts of the enclosure. The push button shall have "Push for Help" lettering engraved in a contrasting color.
 - h. Braille Instructional Signs:
 - 1) Provide Braille instructional signage with each area station. Sign will be enclosed in a stainless steel frame with tamperproof screws (hardware). Text is to conform with the Americans with Disabilities Act Requirements 4.30.4 for text size and style. Text is to be in Braille and English and is to read "FOR ASSISTANCE PUSH 3 INCH HELP BUTTON."
 - 2) Mount adjacent to area station 44 inches above finished floor.
 - i. Cabling Requirements: Each remote station up to 200 feet from master shall be connected with 5 twisted pair #20 AWG with overall shield. 200-500 feet shall be connected with 5 twisted pair #18 AWG with overall shield. 500-1000 feet shall be connected with 5 twisted pair #16 AWG with overall shield.
3. Pathway installation
 - a. All cabling shall be installed in conduit. Conceal all cabling in facility.
 - b. Verify all cabling requirements with manufacturer's requirements and confirm on submittals.

4. Pathway Survivability:
 - a. Riser Cables: Level 2 or 3.
 - b. Feeder Cables: Level 0.

END OF SECTION 284800



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