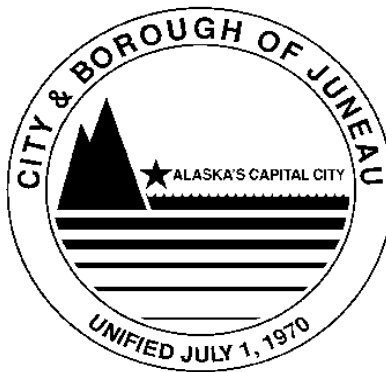


**City and Borough of Juneau (CBJ)
Consolidated Public Works Facility
Streets Wing Addition**

**VOLUME II OF III
Divisions 8 through 16**

Contract No. E10-273

File No. 1611



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SECTION 09260 – GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Interior gypsum wallboard.
2. Non-load-bearing interior metal stud wall framing.
3. Metal furring.
4. Suspended framing systems for gypsum board ceilings.
5. Sound batt acoustical insulation.

B. Related Sections include the following:

1. Section 05400 - Cold-Formed Metal Framing for exterior wall framing.

1.2 PERFORMANCE REQUIREMENTS

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

1. Design Loads:

- a. Dead Loads: Weights of materials and construction.
- b. Seismic Loads: 5 pounds per square foot lateral load on interior partitions.

2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

- a. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height.

3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

- a. Upward and downward movement of 1 inch.

B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."

1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."

1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Show locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, profiles and metal thickness for all components, details of components, and attachments to other units of Work.
- C. Allowable Span Tables: Submit manufacturer's allowable span tables for wall studs.
- D. Samples: For the following products:
 1. Trim Accessories: Full-size sample in 12-inch- long length for each trim accessory indicated.
- E. Evaluation Reports: Submit International Code Council and/or ICBO evaluation reports under which the submitted allowable span tables are approved.

1.4 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and that of the listed document, the requirements of this Section shall govern.

<u>Reference</u>	<u>Title</u>
40 CFR, Part 59D	National Volatile Organic Compound Emission Standards for Architectural Coatings
ASTM A153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A366	Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A510	Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
ASTM A641	Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653	Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C11	Terminology Relating to Gypsum and Related Building Materials and Systems
ASTM C36	Specification for Gypsum Wallboard
ASTM C475	Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C630	Specification for Water-Resistant Gypsum Backing Board
ASTM C645	Specification for Nonstructural Steel Framing Members
ASTM C665	Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C754	Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C834	Specification for Latex Sealants

ASTM C840	Specification for Application and Finishing of Gypsum Board
ASTM C919	Practice for Use of Sealants in Acoustical Applications
ASTM C954	Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inch to 0.112 inch in Thickness
ASTM C1002	Specification for Steel Drill Screws for the Application of Gypsum Panel products or Metal Plaster Bases
ASTM C1047	Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM E84	Test Methods for Fire Tests of Building Construction and Materials
ASTM E488	Test Methods for Strength of Anchors in Concrete and Masonry Elements
ASTM E1190	Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members
GA-214	Recommended Levels of Gypsum Board Finish
GA-216	Application and Finishing of Gypsum Board: Specifications
GA-600	Fire Resistance Design Manual

Steel Stud Manufacturers Association

ICBO ER 4943-P	SMSA Product Technical Information
	SMSA Technical Note 1: Single Deflection Track Selection
	SMSA Technical Note 2: Unsheathed Flange Bracing
	SMSA Technical Note 3: Track within a Track Deflection Assembly

UL	Fire Resistance Directory
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- B. Gypsum Board Finish Mockups: Before finishing gypsum board assemblies, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and qualities of materials and execution.

1. Install mockups for the following applications:
 - a. Typical interior gypsum board wall for each finish level specified.
 - b. Typical interior gypsum board ceiling for each finish level specified.
2. Simulate finished lighting conditions for review of mockups.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Steel Framing, Manufacturer: Subject to compliance with requirements, manufacturers of metal framing components shall belong to the Steel Stud Manufacturers Association.
- B. Steel Framing, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Metal complying with ASTM C 645 requirements.
 - a. Protective Coating:
 - 1) Interior Applications: ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
 - 2) Exterior Applications: ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

2.2 STEEL SUSPENDED CEILING FRAMING

- A. Components, General: Comply with ASTM C 754 for conditions indicated.
- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.
- C. Hangers:
 - 1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch, a minimum 1/2-inch- wide flange, with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
 - 1. Depth: 2 inches minimum.
- E. Furring Channels (Furring Members): Commercial-steel sheet with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
 - 1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base Metal Thickness: 0.0312 inch.

2.3 STEEL PARTITION FRAMING

A. Components, General: As follows:

1. Comply with ASTM C 754 for conditions indicated.
2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.

B. Steel Studs and Runners: ASTM C 645.

1. Minimum Base Metal Thickness: 0.027 inch.
2. Depth: As indicated.

C. Slip-Type Head Joints: Provide one of the following in thickness not less than indicated for studs and in width to accommodate depth of studs:

1. Deep-Leg Deflection Track: ASTM C 645 top runner with 2-inch- deep flanges.
2. Proprietary Deflection Track: Steel sheet top runner manufactured to prevent cracking of gypsum board applied to interior partitions resulting from deflection of structure above; in thickness indicated for studs and in width to accommodate depth of studs.
 - a. Available Product: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 1. Brady Construction Innovations, Inc., Sliptrack Systems.
 2. Delta Star, Inc., Superior Metal Trim; Superior Flex Track System (SFT).
 3. Metal-Lite, Inc.; Slotted Track.

D. Flat Strap and Backing Plate for Fixture Attachment: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base Metal Thickness: 0.0312 inch.

E. Cold-Rolled Channel Bridging: 0.0538-inch bare steel thickness, with minimum 1/2-inch- wide flange.

1. Depth: As indicated; 1-1/2 inches if no indication on the Drawings.
2. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch- thick, galvanized steel.

F. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.4 INTERIOR GYPSUM WALLBOARD

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

B. Gypsum Wallboard: ASTM C 36.

1. Gypsum board facing paper and gypsum core shall both be 100% recycled content.

2. Potential sources of high recycled content gypsum board include, but are not limited to the following:

- a. G-P Gypsum, Tacoma, WA, or approved equal.

3. Type X:

- a. Thickness: 5/8 inch.

- b. Long Edges: Tapered.

- c. Location: Vertical surfaces and where required for fire-resistance-rated assembly.

- C. Sag-Resistant Gypsum Wallboard: ASTM C 36, manufactured to have more sag resistance than regular-type gypsum board.

1. Thickness: 1/2 inch.

2. Long Edges: Tapered.

3. Location: Ceiling surfaces.

2.5 Water Resistant GWB PANELS

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

- B. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M.

1. Core: 5/8 inch, Type X.

2. Location: Wet areas.

2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.

1. Material: Prefinished copolymer fully embedment tapered trims bonded to taping paper.

2. Basis of Design Product: No-coat drywall trims manufactured by Drywall Systems International, or approved equal.

3. Shapes:

- a. Outside Corners: No-Coat "UltraCorner," or approved equal.

- b. Inside Corners: No-Coat "UltraFlex," or approved equal.

- c. No Coat "L-Trim," or approved equal.

- d. Expansion (Control) Joint: Use where required.

2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475. All materials standard weight.

- B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.

- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints and damaged surface areas, use setting-type or drying-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
- D. Joint Compound for Water-Resistant Backing Panels:
 - 1. Water-Resistant Gypsum Backing Board: Use setting-type or drying type taping and sandable topping compounds.

2.8 ACOUSTICAL SEALANT

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
 - b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.
 - 2. Acoustical Sealant for Concealed Joints:
 - a. Ohio Sealants, Inc.; Pro-Series SC-170 Rubber Base Sound Sealant.
 - b. Pecora Corp.; BA-98.
 - c. Tremco, Inc.; Tremco Acoustical Sealant.
- B. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- C. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.

2.9 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

C. Isolation Strip at Exterior Walls:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool; 2 inches thick, unless noted otherwise.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.
 1. Provide attachments to roof decking and roof structure in advance of time needed for coordination and construction.

3.3 INSTALLING STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Construction Details: Where details are not shown on the Drawings, provide details recommended by the Steel Stud Manufacturers Association.
- C. Provide supplementary framing, blocking, and bracing to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Isolate steel framing from building structure to prevent transfer of loading imposed by structural movement.

1. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints or proprietary deflection track at head of wall assemblies that abut roof deck or roof structure.
 - a. Use built-up or proprietary deflection track where construction is not fire-rated.
 - b. Use proprietary firestop track where construction is fire-rated.

3.4 INSTALLING STEEL SUSPENDED CEILING FRAMING

A. Suspend ceiling hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
4. Secure hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel deck tabs.
6. Do not attach hangers to steel roof deck. Attach hangers to structural members.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member and transversely between parallel members.

C. Sway-brace suspended steel framing in both directions.

D. Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

E. Install suspended steel framing components in sizes and spacings not less than that required by the referenced steel framing and installation standards, unless larger members and/or closer spacing are indicated on the Drawings.

1. Hangers: 48 inches o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 16 inches o.c.

- F. Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track or angle.

3.5 INSTALLING STEEL PARTITION FRAMING

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
 - 1. Where studs are installed directly against exterior walls, install asphalt-felt or foam-gasket isolation strip between studs and wall.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
 - 1. Cut studs 1/2 inch short of full height to provide perimeter relief.
 - 2. For fire-resistance-rated partitions that extend to the underside of floor deck or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
- D. Install steel studs and furring at 16 inches o.c., unless otherwise indicated.
- E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
- F. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - 1. Extend jamb studs to underside of roof structure above.
- G. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- H. Where stud flanges are not sheathed, brace stud flanges at 48-inch o.c. vertically minimum with flat strap attached to each stud and solid stud blocking 48-inch o.c. along the straps and at wall ends, with two screws through blocking bent webs to each adjoining stud and three screws through the strap to each blocking.
- I. Polyethylene Vapor Retarder: Install to comply with requirements specified in Division 7 Section 07210, Building Insulation.

3.6 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.
- B. Install sound attenuation blankets where indicated on the Drawings before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Form control and expansion joints with space between edges of adjoining gypsum panels.
- I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of roof decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.
- J. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 3/8-inch- wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- K. Where walls with acoustical sealant are noted on the Drawings, seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.
- L. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

3.7 PANEL APPLICATION METHODS

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.

B. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.8 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and only in locations approved by Project Representative for visual effect.

3.9 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 1. Level 1: In ceiling plenum areas and fully concealed areas unless a higher level of finish is required for sound-rated assemblies.
 2. Level 3: At panel surfaces that will be exposed to view, unless otherwise indicated. Provide with light orange peel finish.

3.10 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, the Project Representative will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.

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1. Notify Project Representative seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.

END OF SECTION 09260

SECTION 09512 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes acoustical tiles and suspension systems for ceilings.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordination Drawings: Drawn to scale and coordinating acoustical tile ceiling installation with hanger attachment to building structure and ceiling mounted items. Show size and location of initial access modules.
- C. Samples: For each exposed finish.
- D. Product test reports.
- E. Research/evaluation reports.
- F. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory.
- B. Fire-Test-Response Characteristics:
 - 1. Fire-Resistance Characteristics: Where indicated, provide acoustical tile ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 2. Surface-Burning Characteristics: Acoustical tiles complying with ASTM E 1264 for Class A materials, when tested per ASTM E 84.
 - a. Smoke-Developed Index: 450 or less.
- C. Seismic Standard: Comply with the following:
 - 1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.

2. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
3. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."
4. UBC Standard 25-2, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."
5. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

PART 2 - PRODUCTS

2.1 ACOUSTICAL TILE CEILINGS, GENERAL

- A. Acoustical Tile Standard: Comply with ASTM E 1264.
- B. Metal Suspension System Standard: Comply with ASTM C 635.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- D. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 1. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.
- E. Seismic struts and seismic clips.
- F. 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.

2.2 ACOUSTICAL TILES FOR ACOUSTICAL TILE CEILING

- A. Basis-of-Design Product: Armstrong World Industries fine fissured, angled tegular edge profile. 24 by 48 by 15/16-inch panels with prelude XL suspension system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with UBC Standard 25-2 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

- B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders.
- C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 1. Do not support ceilings directly from permanent metal forms or floor deck; anchor into concrete slabs.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical tiles in coordination with suspension system and exposed moldings and trim.

END OF SECTION 09512

SECTION 09651 - RESILIENT FLOOR TILE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber floor tile.

1.2 SUBMITTALS

- A. Product Data:** For each type of product indicated.
- B. Shop Drawings:** For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
- C. Samples:** Full-size units of each color and pattern of floor tile required.
- D. Maintenance data.**

1.3 QUALITY ASSURANCE

- A. 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.

1.4 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive floor tile.**
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.**
- C. Close spaces to traffic during floor tile installation.**
- D. Close spaces to traffic for 48 hours after floor tile installation.**
- E. Install floor tile after other finishing operations, including painting, have been completed.**

PART 2 - PRODUCTS

2.1 RUBBER FLOOR TILE

- A. Products: Subject to compliance with requirements, provide:

Basis of Design Product: Johnsonite RT-28-SQ or comparable product by one of the following:.

1. Estrie Products International, American Biltrite (Canada) Ltd.
2. Flexco.
3. Johnsonite.
4. Mondo Rubber International, Inc..
5. Nora Rubber Flooring, Freudenberg Building Systems, Inc.
6. PRF USA Inc.
7. R.C.A. Rubber Company (The).
8. Roppe Corporation, USA.

- B. Tile Standard: ASTM F 1344, Class I-B, homogeneous rubber tile, through mottled.

- C. Hardness: Not less than 85 as required by ASTM F 1344, measured using Shore, Type A durometer per ASTM D 2240.

- D. Wearing Surface: Molded pattern.

1. Molded-Pattern Figure: Raised squares.

- E. Thickness: 0.125 inch.

- F. Size: 24 by 24 inches.

- G. Colors and Patterns: As selected by Architect from full range of industry colors.

2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

- B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.

1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. VCT and Asphalt Tile Adhesives: Not more than 50 g/L.
 - b. Rubber Floor Adhesives: Not more than 60 g/L.

- C. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - 4. Moisture Testing: Perform tests recommended by floor covering manufacturer and as follows. Proceed with installation only after substrates pass testing.
 - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until they are same temperature as space where they are to be installed.
 - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.2 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- G. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.3 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor tile.
- B. Floor Polish: Remove soil, visible adhesive and surface blemishes from floor tile surfaces before applying liquid floor polish.
 - 1. Apply two coat(s).
- C. Cover floor tile until Substantial Completion.

END OF SECTION 09651

SECTION 09653 - RESILIENT WALL BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resilient base.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.

1.3 QUALITY ASSURANCE

A. 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.

1.4 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive resilient products.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 RESILIENT BASE

A. Resilient Base:

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. Allstate Rubber Corp.; Stoler Industries.
- b. Armstrong World Industries, Inc.
- c. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
- d. Endura Rubber Flooring; Division of Burke Industries, Inc.
- e. Estrie Products International; American Biltrite (Canada) Ltd.
- f. Flexco, Inc.
- g. Johnsonite.
- h. Mondo Rubber International, Inc.
- i. Musson, R. C. Rubber Co.
- j. Nora Rubber Flooring; Freudenberg Building Systems, Inc.
- k. PRF USA, Inc.
- l. Roppe Corporation, USA.
- m. VPI, LLC; Floor Products Division.

B. Resilient Base Standard: ASTM F 1861.

- 1. Material Requirement: Type TS (rubber, vulcanized thermoset) or Type TP (rubber, thermoplastic).
- 2. Manufacturing Method: Group I (solid, homogeneous).
- 3. Style: Cove (base with toe).

C. Minimum Thickness: 0.125 inch.

D. Height: 4 inches.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Preformed.

G. Inside Corners: Job formed.

H. Finish: As selected by Architect from manufacturer's full range.

I. Colors and Patterns: As selected by Architect from full range of industry colors.

2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are same temperature as the space where they are to be installed.
 - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- D. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.2 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.

3.3 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

END OF SECTION 09653

SECTION 09912 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete.
 - 2. Steel.
 - 3. Galvanized metal.
 - 4. Gypsum board.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each finish and for each color and texture required.
- C. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.3 QUALITY ASSURANCE

- A. MPI Standards:
 - 1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 - 2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.
- B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft.
 - b. Other Items: Architect will designate items or areas required.
 - 2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
 - 3. Final approval of color selections will be based on benchmark samples.

- a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.

C. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
2. Restricted Components: Paints and coatings shall not contain any of the following:
 - a. Acrolein.
 - b. Acrylonitrile.
 - c. Antimony.
 - d. Benzene.
 - e. Butyl benzyl phthalate.
 - f. Cadmium.
 - g. Di (2-ethylhexyl) phthalate.
 - h. Di-n-butyl phthalate.
 - i. Di-n-octyl phthalate.

- j. 1,2-dichlorobenzene.
- k. Diethyl phthalate.
- l. Dimethyl phthalate.
- m. Ethylbenzene.
- n. Formaldehyde.
- o. Hexavalent chromium.
- p. Isophorone.
- q. Lead.
- r. Mercury.
- s. Methyl ethyl ketone.
- t. Methyl isobutyl ketone.
- u. Methylene chloride.
- v. Naphthalene.
- w. Toluene (methylbenzene).
- x. 1,1,1-trichloroethane.
- y. Vinyl chloride.

- D. Colors: As selected by Architect from manufacturer's full range.

2.2 PRIMERS/SEALERS

- A. Interior Latex Primer/Sealer: MPI #50.

2.3 METAL PRIMERS

- A. Alkyd Anticorrosive Metal Primer: MPI #79.

2.4 LATEX PAINTS

- A. Institutional Low-Odor/VOC Latex (Eggshell): MPI #145 (Gloss Level 3).
 - 1. VOC Content: E Range of E3.
 - 2. Environmental Performance Rating: EPR 4.5.
- B. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).
 - 1. VOC Content: E Range of E3.
 - 2. Environmental Performance Rating: EPR 5.5.

2.5 FLOOR COATINGS

- A. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION AND APPLICATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- D. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
 - 1. Mechanical Work:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.
 - d. Tanks that do not have factory-applied final finishes.
 - e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
 - f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

- g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
- 2. Electrical Work:
 - a. Switchgear.
 - b. Panelboards.
 - c. Electrical equipment that is indicated to have a factory-primed finish for field painting.
- E. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- F. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.3 INTERIOR PAINTING SCHEDULE

A. Steel Substrates:

- 1. Institutional Low-Odor/VOC Latex System: MPI INT 5.1S.
 - a. Prime Coat: Rust-inhibitive primer (water based).
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex Semigloss for door frames, eggshell for other surfaces.

B. Galvanized-Metal Substrates (excluding metal deck):

- 1. Institutional Low-Odor/VOC Latex System: MPI INT 5.3N.
 - a. Prime Coat: Waterborne galvanized-metal primer.
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex semigloss.

C. Gypsum Board Substrates:

- 1. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
 - a. Prime Coat: Interior latex primer/sealer.
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex eggshell.

D. FLOOR COATINGS:

- 1. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.

END OF SECTION 09912

SECTION 09960 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes surface preparation and application of high-performance coating systems on the following substrates:
 - 1. New unfinished, primed or galvanized exposed interior steel beams, bents and girts and, columns.
 - 2. New unfinished, primed or galvanized exterior exposed steel.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of finish-coat product indicated.
- C. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.3 QUALITY ASSURANCE

- A. Master Painters Institute (MPI) Standards:
 - 1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 - 2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and coating systems indicated.
- B. Mockups: Apply benchmark samples of each coating system indicated to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each type of coating and substrate.
 - a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft.
 - b. Other Items: Architect will designate items or areas required.
 - 2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
 - 3. Final approval of color selections will be based on benchmark samples.
 - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS, GENERAL

A. Material Compatibility:

1. Provide materials for use within each coating 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. Provide products of same manufacturer for each coat in a coating system.

B. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.
4. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: 250 g/L.
5. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
6. Pre-Treatment Wash Primers: 420 g/L.
7. Floor Coatings: 100 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

C. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
2. Restricted Components: Paints and coatings shall not contain any of the following:
 - a. Acrolein.
 - b. Acrylonitrile.
 - c. Antimony.
 - d. Benzene.
 - e. Butyl benzyl phthalate.
 - f. Cadmium.
 - g. Di (2-ethylhexyl) phthalate.
 - h. Di-n-butyl phthalate.
 - i. Di-n-octyl phthalate.
 - j. 1,2-dichlorobenzene.
 - k. Diethyl phthalate.
 - l. Dimethyl phthalate.
 - m. Ethylbenzene.
 - n. Formaldehyde.
 - o. Hexavalent chromium.

- p. Isophorone.
- q. Lead.
- r. Mercury.
- s. Methyl ethyl ketone.
- t. Methyl isobutyl ketone.
- u. Methylene chloride.
- v. Naphthalene.
- w. Toluene (methylbenzene).
- x. 1,1,1-trichloroethane.
- y. Vinyl chloride.

D. Colors: As selected by Architect from manufacturer's full range.

2.2 METAL PRIMERS

- A. Inorganic Zinc Primer: MPI #19.
- B. Epoxy Zinc Primer: MPI #20.
- C. Rust-Inhibitive Primer (Water Based): MPI #107.
- D. Alkyd Anticorrosive Metal Primer: MPI #79.
- E. Quick-Dry Alkyd Metal Primer: MPI #76.
- F. Waterborne Galvanized-Metal Primer: MPI #134.

2.3 EPOXY COATINGS

- A. Epoxy, Cold-Cured, Gloss: MPI #77.
- B. Water-Based Epoxy (Interior and Exterior): MPI #115.
- C. High-Build Epoxy Marine Coating, Low Gloss: MPI #108.
- D. Epoxy Deck Coating: MPI #82.
- E. Water-Based Epoxy Floor Paint: MPI #93.

2.4 INTERIOR HIGH-PERFORMANCE ARCHITECTURAL LATEX COATINGS

- A. High-Performance Architectural Latex, Velvet Finish: MPI #138, Gloss Level 2.
- B. High-Performance Architectural Latex, Eggshell Finish: MPI #139, Gloss Level 3.
- C. High-Performance Architectural Latex, Satin Finish: MPI #140, Gloss Level 4.
- D. High-Performance Architectural Latex, Semigloss Finish: MPI #141, Gloss Level 5.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
 - 1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 2. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 3. Coating application indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - 1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
- C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
- D. Steel Substrates: Remove rust and loose mill scale using methods recommended in writing by coating manufacturer.
- E. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.5 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Steel Substrates:
 - 1. Water-Based Epoxy Coating System:
 - a. Prime Coat: Rust-inhibitive primer, (water based), MPI #107.
 - b. Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
 - c. Topcoat: Water-based epoxy (interior and exterior), MPI #115.
- B. Galvanized-Metal Substrates:
 - 1. Epoxy Coating System:
 - a. Prime Coat: Cold-curing epoxy primer, MPI #101.
 - b. Topcoat: Epoxy, cold-cured, gloss, MPI #77.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Steel Substrates:
 - 1. High-Performance Architectural Latex Coating System:

- a. Prime Coat: Alkyd anticorrosive metal primer, MPI #79, metal primer, MPI #76.
- b. Intermediate Coat: High-performance architectural latex matching topcoat.
- c. Topcoat: High-performance architectural latex, Semigloss finish, MPI #141, Gloss Level 5.

B. Galvanized-Metal Substrates(excluding metal deck):

1. High-Performance Architectural Latex Coating System:

- a. Prime Coat: Waterborne galvanized-metal primer, MPI #134.
- b. Intermediate Coat: High-performance architectural latex matching topcoat.
- c. Topcoat: High-performance architectural latex, semigloss finish, MPI #141, Gloss Level 5.

END OF SECTION 09960

SECTION 10101 – VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Markerboards.
2. Tackboards.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include elevations, sections, details, and attachments to other work.
1. Include sections of typical trim members and accessories.
 2. Show details of accessories.
- C. Samples: For each type of visual display surface indicated.
- D. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and that of the listed document, the requirements of this Section shall govern.

<u>Reference</u>	<u>Title</u>
AAMA 611	Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum
ASTM A424	Specification for Steel, Sheet, for Porcelain Enameling
ASTM A463	Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM B221	Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ANSI A208.2	Medium Density Fiberboard (MDF)
MS MIL-C-15116-C	Cork Sheet, Bulletin Board

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-built visual display boards completely assembled in one piece without joints.

1.5 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces become slick or shiny.
 - c. Surfaces exhibit crazing, cracking, or flaking.
 - 2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
 - 1. Gloss Finish: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser.
 - 2. Available Products: Subject to compliance with requirements, provide one of the following products, or approved equal.
 - a. Product: PolyVision Corporation; P³ ceramicsteel Markerboard.
 - b. Product: Claridge Products & Equipment, Inc.; LCS Markerboard.
- B. Natural Cork Sheet: Seamless, single layer, compressed fine-grain cork sheet, bulletin board quality; face sanded for natural finish.
- C. Extruded Aluminum: ASTM B 221, Alloy 6063.
- D. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

2.2 MARKERBOARD ASSEMBLIES

- A. Porcelain-Enamel Markerboard Assembly: Balanced, high-pressure, factory-laminated markerboard assembly of 3-ply construction consisting of backing sheet, core material, and 0.021-inch- thick, porcelain-enamel face sheet.
 - 1. Available Manufacturers:
 - a. Claridge Products & Equipment, Inc.
 - b. PolyVision Corporation.
 - 2. Medium Density Fiberboard Core: 7/16 inch thick; with 0.002-inch, aluminum foil.

2.3 MARKERBOARD ACCESSORIES

- A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; of size and shape indicated. Exposed front face of frame section not less than 5/8-inch wide.
 - 1. Factory-Applied Trim: Manufacturer's standard.
- B. Chalktray: Manufacturer's standard, continuous, extruded aluminum solid type with ribbed section and smoothly curved exposed ends.
- C. Map Rail: Provide the following accessories:
 - 1. Display Rail: Continuous and integral with map rail; fabricated from cork approximately 1 to 2 inches wide.
 - 2. End Stops: Located at each end of map rail.
 - 3. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches of map rail or fraction thereof.

2.4 TACKBOARD ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A-1 Visual Systems.
 - 2. AARCO Products, Inc.
 - 3. ADP Lemco, Inc.
 - 4. Aywon.
 - 5. Bangor Cork Company, Inc.
 - 6. Best-Rite Manufacturing.
 - 7. Claridge Products and Equipment, Inc.
 - 8. Egan Visual Inc.
 - 9. EverProducts by Glenroy Inc.
 - 10. Ghent Manufacturing, Inc.
 - 11. Marsh Industries, Inc.; Visual Products Group.
 - 12. Platinum Visual Systems; a division of ABC School Equipment, Inc.
 - 13. PolyVision Corporation; a Steelcase company.
 - 14. Tri-Best Visual Display Products.
- B. Natural-Cork Tackboard: 1/4-inch- thick, natural cork sheet factory laminated to 1/4-inch-thick hardboard backing.

2.5 TACKBOARD ACCESSORIES

- A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; of size and shape indicated. Exposed front face of frame section not less than 5/8-inch wide.
 - 1. Factory-Applied Trim: Manufacturer's standard.

2.6 FABRICATION

- A. Fabricate visual display surfaces to sizes indicated on Drawings.
- B. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
- C. Visual Display Boards: Factory assemble visual display boards, unless otherwise indicated.
- D. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to neat, hairline closure.
 - 1. Trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.
- E. Aluminum Anodic Finish: Class II, clear anodic coating complying with AAMA 611.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, and substances that will impair bond between visual display boards and surfaces.
- B. Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- C. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.
- D. Attach one cleaning label to visual display surface in each room. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 10101

SECTION 10200 – LOUVERS AND VENTS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:

1. Fixed, extruded-aluminum louvers in exterior walls.

B. Related Sections include:

1. Section 07412 - Metal Wall Panels for louver finish.
2. Section 07620 - Sheet Metal Flashing and Trim for flashings around louvers.

1.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance:** Provide louvers capable of withstanding the effects of gravity loads and wind loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward, without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors.
- B. Seismic Performance:** Provide louvers capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads." With seismic design criteria as noted on the structural drawings.
- C. Thermal Movements:** Provide louvers that allow for thermal movements resulting from a temperature change (range) of 90 deg F, ambient; 150 deg F, material surfaces, by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
- D. Air-Performance, Water-Penetration, and Wind-Driven Rain Ratings:** As demonstrated by testing manufacturer's stock units according to AMCA 500-L.

1.03 SUBMITTALS

- A. Product Data:** For each type of product indicated, include printed catalog pages showing AMCA Certified Ratings Seals.
- B. Shop Drawings:** Include plans, elevations, sections, details, and attachments to other Work.
1. Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.
- C. Samples:** For each type of finish.
- D. Product test requirements.**

1.04 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and that of the listed document, the requirements of this Section shall govern.

<u>Reference</u>	<u>Title</u>
AMCA 500-L	Test Methods for Louvers, Dampers
AAMA 2605	Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
ASTM B221	Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
ASTM D1187	Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASCE 7	Minimum Design Loads for Buildings and Other Structures
AWS D1.2	Structural Welding Code - Aluminum
NAAMM	Metal Finishes Manual for Architectural and Metal Products

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Louvers:

- a. Airline Products Co.
- b. Airolite Company (The).
- c. American Warming and Ventilating, Inc.
- d. Arrow United Industries.
- e. Carnes Company, Inc.
- f. Cesco Products.
- g. Construction Specialties, Inc.
- h. Dowco Products Group; Safe-Air of Illinois, Inc.
- i. Greenheck.
- j. Industrial Louvers, Inc.
- k. Louvers & Dampers, Inc.
- l. Metal Form Manufacturing Company, Inc.
- m. NCA Manufacturing, Inc.
- n. Nystrom Building Products.
- o. Reliable Products; Hart & Cooley, Inc.
- p. Ruskin Company; Tomkins PLC.
- q. Vent Products Company, Inc.

- B. Basis-of-Design Product: The design for each louver is based on the product named. Subject to compliance with requirements, provide the named product or an approved comparable product by one of the other manufacturers specified.

2.02 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, drainable-Blade Louver:

1. Basis-of-Design Product: Greenheck EDD-601.
2. Depth: 6 inches.
3. Blade Profile: Plain blade with upward offset on each blade and upward hook at the top of each blade
4. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
5. Performance Requirements:
 - a. Free Area: Not less than 8.0 sq. ft. for 48-inch- wide by 48-inch- high louver.
 - b. Point of Beginning Water Penetration: Not less than 700 fpm free area velocity.
 - c. Air Performance: Not more than 0.10-inch wg static pressure drop at 700 fpm free-area velocity.

B. Horizontal, Door Louver:

1. Basis-of-Design Product: Greenheck ESF-145.
2. Depth: 1 1/2 inches.
3. Blade Profile: Plain blade with upward offset on each blade and upward hook at the top of each blade.
4. Frame and Blade Nominal Thickness: Not less than 0.080 inch.

2.03 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, alloy 6063-T5 or T-52.
- B. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.04 FABRICATION, GENERAL

- A. Fabricate frames to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- B. Join frame members to each other and to louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view.

2.05 LOUVER SCREENS

- A. General: Provide screen at interior face of each exterior louver behind which there is interior space.
- B. Louver Screen Frames: Same kind and form of metal and finish as indicated for louver to which screens are attached.
- C. Louver Screening:
 1. Insect/Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.

2.06 FINISHES

- A. Finish all louver metal with AAMA 2605 compliant finish coating identical in product, quality and color to exterior face of predominant adjacent metal wall panels.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work. Coordinate with installation of sheet metal flashings around louvers.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- E. Protect metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

END OF SECTION 10200

SECTION 10522 - FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fire protection cabinets for fire extinguishers.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
- B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- C. Coordinate sizes and locations of fire protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

2.2 FIRE PROTECTION CABINET

- A. Cabinet Type: Surface Mount and Semi Recessed.
 - 1. Products: Subject to compliance with requirements, provide the following or approved equal.
 - a. Larsen's Manufacturing Company; FS 2712SM and 2712 RA with full panel glazing of tempered safety glass.

2.3 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style as indicated . Miter and weld joints and grind smooth.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed and prepare recesses as required by type and size of cabinet and trim style.
- B. Install fire protection cabinets in locations noted on plans, and at mounting heights acceptable to authorities having jurisdiction.
- C. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
- D. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10522

SECTION 10523 – FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.
- C. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
- C. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation.
 - b. Ansul Incorporated; Tyco International Ltd.
 - c. Badger Fire Protection; a Kidde company.
 - d. Buckeye Fire Equipment Company.
 - e. Fire End & Croker Corporation.
 - f. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - g. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
 - h. Larsen's Manufacturing Company.
 - i. Moon-American.
 - j. Pem All Fire Extinguisher Corp.; a division of PEM Systems, Inc.
 - k. Potter Roemer LLC.
 - l. Pyro-Chem; Tyco Safety Products.
 - 2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type UL-rated 2A-10BC nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.2 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

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- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 10523

SECTION 11160 – VEHICLE LIFT SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies an ADDITIVE ALTERNATE for furnishing, installing, and start-up of the vehicle lift within Room 117 Bay 2 of the existing building.
- B. Related Sections
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 01810 – Testing, Commissioning, and Training
 - 3. Section 15050 – Basic Mechanical Requirements

1.2 QUALITY ASSURANCE

- A. Design Standards and Certification – The lift shall be certified by ETL to the ANSI/ALI Standard for Automotive Lifts, ALCTV-2006: Safety Requirements for Construction, Testing and Validation and UL201.
- B. Qualifications – The lift distributor/installer shall be approved as a factory authorized installer by the same manufacturer supplying the lift equipment.
- C. Distributor/installer shall provide technical training of the owner's personnel in the operation and maintenance of specified equipment.

1.3 SUBMITTAL REQUIREMENTS

- A. Shop Drawings – Submit shop drawings showing full layout with dimensions and details shown for services and conduits between lift and the control console.
- B. Product Data – Submit product data in detail, including site drawings, equipment drawings and specifications.
- C. Operation and Maintenance Manual – Submit Owner's manual to include system operation, maintenance and trouble shooting, spare part numbers and drawings and schematics.

1.4 WARRANTY

- A. The lift shall be warranted against defects in materials and workmanship for a period of two (2) years parts and one (1) year labor on all components following the training date of the product.

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. 01810: General Commissioning Requirements

PART 2 - PRODUCTS

2.1 PARALLELOGRAM PLATFORM LIFT (FLUSH MOUNTED)

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Rotary Lift.
 - 2. Or approved equal.
- B. Basis of Design product is Rotary Lift 50/26F.
 - 1. Complete assembly shall consist of an electro-hydraulic lift unit, a control console and any accessories as specified herein. The control console shall be connected by required lengths of stainless steel hydraulic pipe or steel reinforced hydraulic hose, nylon compressed air line and electrical cable approved for use in the lift units eventual installed location.
 - a. Sufficient lengths of hydraulic pipe or hose, air line and electrical cable shall be supplied with the lift to permit locating the control console 50 feet (minimum) from the connections on the lift unit.
 - b. Hydraulic interconnections shall have standard JIC fittings throughout.
 - 2. Lifting capacity: 25 tons (50,000 lbs.) per lift unit, minimum.
 - 3. Minimum lifting height from finished floor level to bottom of tires: 63 inches, minimum. Lifting unit shall permit lifting of vehicle to any height up to this full amount with a minimum of 13 locking positions distributed throughout the lifts travel.
 - a. First lock position shall be 12 inches minimum to allow comfortable and safe brake/tire work at this height.
 - 4. Lifting speed: 58 Seconds.
 - 5. Platform dimensions.
 - a. Platform length: 312 inches.

- b. Platform width: 32 inches.
- c. Spacing between platforms: 45 inches.
- d. Overall width: 109 inches.
- e. Collapsed height: 0 inches To Finished Floor Level

6. Safety Mechanism Requirements.

- a. Support leg joints shall be provided with hardened bushings at the cylinder to leg connection and the leg to platform connection, where stresses are at a maximum, for extended lift life and easy repair.
- b. Each platform shall be constructed of 0.375 inch thick steel plate supported by 0.250 inch thick steel beams.
- c. Each platform shall have two wheel chocks constructed of 0.375 inch thick steel plate mounted to the front and rear of the lift to prevent a vehicle from rolling off the front or rear of the lift when raised more than 12 inches.
 - 1) Chocks shall automatically swing into position as the lift is raised and automatically recede when lowered.
 - 2) Chocks shall not reduce the effective length of lifting platforms by more than 6 inches.
 - 3) Wheel chocks shall be interchangeable.
 - 4) Chocks shall be securely pinned to platform to prevent casual removal by shop personnel.
 - 5) Chock design shall provide for a minimum of 2 inches upward movement to prevent injury to personnel or damage to lift unit in the event of obstruction between lift unit and wheel chock.

7. Leveling/Anchoring provisions.

- a. The base of each lifting member shall provide for a minimum of 1 inch vertical adjustment. The adjustment of one lifting member shall be independent of adjustment of a different lifting member to accommodate uneven slab shifting/settling.
- b. The base of each lifting member shall be pre-drilled to accept anchoring bolts adequately sized for the loads imposed during lift operation.

8. There shall be no fixed obstructions between lifting platforms.

9. Hydraulic system.

- a. All hydraulic system components shall comply with section 1.1.2 above.
- b. Each hydraulic cylinder shall have a flow check integrally mounted to prevent collapse in the event of a major fluid leak.
- c. Hydraulic cylinders shall be mounted to the underside of the lifting platforms away from sources of dirt, grime, and damage from falling objects.
- d. All hydraulic hoses shall be of steel reinforced construction and have standard JIC fittings throughout.
- e. The lift shall be driven by a hydraulic gear pump of U.S. manufacture, capable of supplying the appropriate PSI and GPM to operate the lift.
- f. The lift shall be able to be lowered from any raised position by operation of a manual pump and valving.

10. Safety locks.

- a. Steel safety locks with a safety factor of not less than 3:1 shall be mounted one set to each lifting cylinder and shall allow the lift to be locked at a minimum of 13 different levels. These locks shall ensure a minimum amount of travel in the event of a hydraulic fluid leak and shall maintain the height of the lift in that situation.
- b. The safety locks shall be automatically disengaged when the lift "Lower" control is operated, and automatically re-engaged when the lift "Lower" control is released. The safety locks shall be automatically engaged as the lift ascends. This will ensure positive lock engagement when raising the lift in the event of hydraulic failure.

11. The lift shall have full length continuous safety tapeswitch mounted to the lower surface of the main lifting platform. Safety tapeswitch will be located on the inside and the outside of both platforms. When any of these tapeswitch are displaced horizontally or vertically, the lift will stop. Tapeswitch inside optional.

12. Control console shall house the following equipment:

- a. Oil reservoir, suction strainer, low pressure return filter, hydraulic gear pump and manual pump.
- b. Electric motor; 208/230/460 volt 3 phase 60 Hz TEFC of U.S. manufacture, 20 HP minimum. Motor shall not require rework for replacement.
- c. Electrical enclosures for control components shall be NEMA 12 rated (minimum) and have the following controls mounted on them while still maintaining their sealing ability:
 - 1) System disconnect
 - 2) "Power-On" pilot lamp
 - 3) "Raise" and "Lower" controls and "Press to lock lift" control
 - 4) "Operator Lock-Out" pilot lamp
- d. The control system shall be tested and approved by a Nationally Recognized Testing Laboratory as established by OSHA to UL 508.

13. The control system shall be operated by a Programmable Logic Control (PLC) and lock-out all operations of lift controls if an unsafe condition exists due to insufficient air pressure to operate safety locks; displaced safety tapeswitch or uneven platform heights. This lock-out shall not be able to be reset unless the unsafe condition has been corrected.

- a. The control system shall ensure that lifting platforms differ in height by no more than 2 inches. If platforms become uneven by a greater amount, the lift shall stop and lock-out operator.
- b. Control system shall be able to be programmed to stop lift at a specific height in order to load or unload any accessory jack.

14. Lighting System

- a. Main lifting platforms shall have fluorescent lights installed on their inner edges to illuminate the work area beneath the vehicle when raised on the lift.
- b. Lighting system shall consist of six (6) individual 40 watt, dual pin, 48 inch bulb, cool-white fluorescent lamp units. Lamp units shall be installed evenly spaced, three (3) to each platform.
- c. Individual lamp units shall be of unitized water-proof construction and shall contain any ballast/starter assembly integral within the individual lamp unit.
- d. Lighting system shall turn on automatically when lift unit is raised above finished floor level 22 inches, (18 1/2 inch lamp height), and shall turn off automatically when lift unit descends below 22 inches as per National Electric Code Section 511-1 through 511-3.
- e. Lamp units shall be installed in a recessed area of the main lifting platforms to be protected from damage caused by falling objects.
- f. Fluorescent bulbs of individual lamp units shall be protected by clear shatter-proof tubes which shall shield personnel and act to contain glass fragments in the event of bulb breakage.

PART 3 - EXECUTION

3.1 INSTALLATION AND COORDINATION

- A. Distributor/installer shall coordinate with the Contractor the layout and placement of conduit from the lift to the Control Console.
- B. Distributor/installer shall coordinate with the Contractor and Owner or Owner's Representative on location of all electrical and mechanical utilities and equipment to be provided and connected by others.
- C. Installation shall be performed by qualified Factory Authorized and trained personnel.
- D. Distributor/installer shall provide installation of equipment and connections of all service lines from the lift to the control console with labor, service, and incidentals necessary for complete and operational equipment installation.

END OF SECTION 11160

SECTION 11450 – RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Freestanding refrigerator.
2. Cooktop.
3. Kitchen exhaust ventilation
4. Microwave.
5. Dishwasher.
6. Washer and dryer.

1.2 SUBMITTALS

- A. Appliance Schedule: Use same designations indicated on the Drawings.
- B. Product Data: For each type of product indicated.
- C. Samples or color chart of manufacturer's complete color range for each exposed finish.
- D. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and that of the listed document, the requirements of this Section shall govern.

<u>Reference</u>	<u>Title</u>
NAECA	Standards
EPA/DOE	Energy Star Program
FTC	Appliance Labeling Rule
NFPA 70	National Electrical Code (Article 100)

- B. Installer Qualifications: An employer of workers trained and approved by manufacturer for installation and maintenance of units required for this Project.
- 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.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer of each appliance specified agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.
1. Electric Cooktop: Five-year limited warranty for in-place service on surface-burner elements.
 2. Microwave Oven: Five-year limited warranty for in-place service on defects in the magnetron tube.
 3. Refrigerator/Freezer: Five-year limited warranty for in-place service on the sealed refrigeration system.
 4. Dishwasher: 10-year warranty for in-place service against deterioration of tub and door liner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Basis-of-Design Product: The design for each residential appliance is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified. Comparable products shall be subject to approval. Submit proposed comparable products for approval.

2.2 COOKING APPLIANCES

A. Microwave:

1. Available Manufacturers:
 - a. Amana Appliances.
 - b. Dacor.
 - c. Electrolux Home Products.
 - d. General Electric Company.
 - e. Hotpoint.
 - f. KitchenAid.
 - g. Maytag.
2. Basis-of-Design Product: GE Profile 2.0 cu.ft. countertop Microwave Oven # PEB2060DMWW.

B. Cooktop.

1. Available Manufacturers:
 - a. Amana Appliances.

- b. BOSCH, BSH Home Appliances Corporation.
 - c. Dynamic Cooking Systems, Inc.
 - d. General Electric Company.
 - e. Hotpoint.
 - f. KitchenAid.
 - g. Maytag.
 - h. Miele, Inc.
 - i. Whirlpool Corporation.
- 2. Basis-of-Design Product: GE #PP962BMBB.
- 3. Type: Five electric burner elements – front controls – frameless design.
- 4. Finish: Black.

2.3 KITCHEN EXHAUST VENTILATION

A. Overhead Exhaust Hood

- 1. Basis of Design Product : Inca Pro 30 (remote blower version)
- 2. Type: Built-in mounting system
- 3. Exhaust Fan: Built into hood with 900 to 1200cfm capacity
 - a. Venting: Vented to outside through wall as indicated on drawings.
- 4. Finish: Stainless Steel.

2.4 REFRIGERATION APPLIANCES

A. Free-Standing Refrigerator/Freezer:

- 1. Available Manufacturers:
 - a. Amana Appliances.
 - b. Electrolux Home Products.
 - c. Westinghouse.
 - d. General Electric Company.
 - e. Hotpoint.
 - f. Frigidaire.
 - g. KitchenAid.
 - h. Maytag.
 - i. Whirlpool Corporation.
- 2. Basis-of-Design Product: Kenmore #77182.
- 3. Type: Freestanding frost-free, energy star, refrigerator/freezer.
- 4. Storage Capacity:
 - a. Total Capacity: 21.0 cu. ft.
 - b. Icemaker.
 - c. Top freezer.

5. Exterior Finish: White.
6. Features: Icemaker, humidity control crispers.

2.5 DISHWASHER APPLIANCES

A. Dishwasher:

1. Available Manufacturers:
 - a. Amana Appliances.
 - b. AM Appliance Group (ASKO).
 - c. BOSCH, BSH Home Appliances Corporation.
 - d. Electrolux Home Products.
 - e. Fisher & Paykel.
 - f. Gaggenau.
 - g. General Electric Company.
 - h. Hotpoint.
 - i. KitchenAid.
 - j. Maytag.
 - k. Miele, Inc.
 - l. Viking Range Corporation.
 - m. Whirlpool Corporation.
2. Basis-of-Design Product: General Electric PDW 8680 JSS or a comparable product by one of the following:
3. Type: Under the counter 24 inches wide, operable at water pressures from 15 to 120 psi.
4. Front Panel: Stainless-steel door front and lower access panel.

B. Washer:

1. Basis of Design Product: GE #WPRE8150HWT, 3.5 cu. ft. capacity, energy star qualified.

C. Dryer:

1. Basis of Design Product: GE #DLSR483EGWW long vent 5.7 cu. ft. capacity.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

- B. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- C. Utilities: Refer to Divisions 15 and 16 for plumbing and electrical requirements.

END OF SECTION 11450

SECTION 11521 – PROJECTION SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated projection screens and controls.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For projection screens. Show layouts and types of projection screens. Include the following:

1. For manually operated projection screens and controls:
 - a. Location of screen centerline relative to ends of screen case.
 - b. Location of seams in viewing surfaces.
 - c. Anchorage details.

PART 2 - PRODUCTS

2.1 MANUALLY OPERATED PROJECTION SCREENS

A. General: Manufacturer's standard spring-roller-operated units consisting of case, screen, mounting accessories, and other components necessary for a complete installation.

B. Surface-Mounted, Metal-Encased, Manually Operated Screens: Units designed and fabricated for surface mounting on wall, fabricated from formed metal or aluminum extrusions; with powder coat finish.

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. Bretford, Inc.; Series 500.
 - b. Da-Lite Screen Company, Model C.
 - c. Draper Inc.
 - d. Stewart Filmscreen Corporation, Luxus Communicator.
2. **Screen Case:** Fabricated in one piece; flat-backed 22 gauge steel case with 16 gauge steel end caps concealing roller ends with steel inner plates to support roller. End caps to form sturdy brackets for wall installation.

- a. Finish: Powder coated; white.

2.2 FRONT-PROJECTION SCREEN MATERIAL

- A. Matte-White Viewing Surface: Peak gain not less than 0.9, and gain not less than 0.8 at an angle of 50 degrees from the axis of the screen surface.
 - 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. BEI Audio-Visual Products; Matte White.
 - b. Bretford, Inc.; Matte White.
 - c. Da-Lite Screen Company; Matte White.
 - d. Draper Inc.; Fiberglass Matte White.
- B. Seamless Construction: Provide screens, in sizes indicated, without seams.
- C. Edge Treatment: Without black masking borders.
- D. Size of Viewing Surface: 60" x 80".

PART 3 - EXECUTION

3.1 FRONT-PROJECTION SCREEN INSTALLATION

- A. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions.
- B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.

END OF SECTION 11521

SECTION 12484 – FLOOR GRATING AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Stainless steel grating and frame.
 - 2. Stainless steel under-grating support framing.
- B. Related sections include:
 - 1. Section 03300 - Cast-in-Place Concrete.

1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.
 - 1. Verify recesses and openings in substrates by field measurements before fabrication and indicate measurements on Shop Drawings.
- C. Samples: 12-inch-square assembled sections of grating, frame members, and accessories required.
- D. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and that of the listed document, the requirements of this Section shall govern.

<u>Reference</u>	<u>Title</u>
ASTM A276	Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
ASTM F593	Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Specification for Stainless Steel Nuts
USATBCB	Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)
NAAMM	Metal Finishes Manual for Architectural and Metal Products

- B. Accessibility Requirements: Comply with "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and requirements of authorities having jurisdiction.
- C. Sole Source: Grating, frames and associated accessories shall be by one manufacturer.

1.4 WARRANTY

- A. Floor grates shall be fabricated free of defects in materials and workmanship and the manufacturer shall offer a five (5) year warranty against defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Basis of Design Products: Subject to compliance with requirements, provide the listed product or approved equal.

2.2 STAINLESS STEEL GRATING AND FRAMES

- A. Furnish and install SSS Clean Tread Model KD98 Stainless Steel Floor Grate and Frame Assembly as manufactured by Kadee Industries, Cleveland, OH (800) 321-3827; Fax (440) 439-6889.
- B. Tread Material: Type 304 stainless steel.
 - 1. 0.071-inch by 0.177-inch wire. Standard slot opening shall be 0.125-inch.
- C. Support Rods: Type 304 stainless steel
 - 1. KD98: 1-inch rods, spaced 1-inch o.c.
- D. Surface finish #4 satin.
- E. Frames and under-grating support framing shall be 304 stainless steel angle.
 - 1. Drainage application: Framing shall consist of intermediate supports spaced no greater than 3 feet apart. Units shall support a uniform load of 300 pounds per square foot.
- F. Shims for support framing and anchorage to concrete bed shall be 304 stainless steel.
- G. Hidden locking devices shall be used to prevent warping and rattling. The number of lockdowns to be used shall be in accordance with the manufacturer's recommendations.

2.3 FABRICATION

- A. Shop fabricate floor grates to greatest extent possible in sizes shown. Where not otherwise shown, provide single unit for each grate installation, but do not exceed manufacturer's maximum size recommendation for units intended for removal and cleaning. Where possible, Contractor must verify field measurement sizes before shop fabrication.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine all areas and conditions where grating is to be installed, and notify the Project Representative of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.2 INSTALLATION

- A. Install recessed floor grates and frames in accordance with manufacturer's instructions, at locations shown. Coordinate top of grate surfaces with doors that swing across grates to provide under door clearance. Coordinate for coplanar installation of grate surface to surrounding floor conditions.

3.3 PROTECTION

- A. Upon completion of frame installation and concrete work, provide temporary filler of plywood or fiberboard in grate recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and project is near time of Substantial Completion.
- B. Installation of grating shall be deferred until near time of Substantial Completion for project.

END OF SECTION 12484

SECTION 12491 – HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Horizontal louver blinds with aluminum slats.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for horizontal louver blinds.
- C. Samples: For each exposed finish.
- D. Product test reports.
- E. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following document. These references are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and that of the listed document, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
NFPA 701	Fire Tests for Flame-Resistant Textile and Films
WCSC A100.1	Safety of Corded Window Covering Products (ANSI)

- B. Fire-Test-Response Characteristics: Provide horizontal louver blinds with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Flame-Resistance Ratings: Passes NFPA 701.
- C. Product Standard: Provide horizontal louver blinds complying with WCSC A 100.1.
- D. Mockups: Build one mockup to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers whose products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hunter Douglas.
 - 2. Levolor, a Newell Rubbermaid Company.
 - 3. Springs Window Fashions Division, Inc.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the following products or approved equal.
 - 1. Levolor, Riveria Lightmaster Dustguard 1-inch Blind, Color #34 brushed aluminum.
- C. Slats: Aluminum; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile.
 - 1. Width: 1 inch.
 - 2. Finish: One color.
 - a. Ionized Coating: Antistatic, dust-repellent, baked polyester finish.
- D. Headrail: Formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and end plugs.
- E. Bottom Rail: Formed-steel or extruded-aluminum tube, with plastic or metal capped ends.
- F. Maximum Light-Blocking Blinds: Designed for eliminating all visible light gaps if slats are tilted closed and with minimal-sized rout holes for ladders hidden and placed near back edge for maximum slat overlap; with headrail and bottom rail extended and formed for light-tight joints between rail and adjacent slats or construction.
 - 1. Finish: Match color, texture, pattern, and gloss of slats.
- G. Ladders: Evenly spaced to prevent long-term slat sag.
 - 1. For Blinds with Nominal Slat Width 1 Inch or Less: Braided string.
- H. Lift Cords: Manufacturer's standard.
- I. Tilt Control: Enclosed worm-gear mechanism and linkage rod.
- J. Lift Operation: Manual.
- K. Mounting: Wall mounting unless indicated otherwise.

2.2 HORIZONTAL LOUVER BLIND FABRICATION

- A. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
 - 1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.
- B. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows:
 - 1. Blind Units Installed outside Jamb: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Installation Brackets: Designed for easy removal and reinstallation of blind, for supporting headrail and operating hardware, and for hardware position and blind mounting method indicated.
- D. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to blind hardware and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
- E. Color-Coated Finish:
 - 1. Metal: For components exposed to view, apply manufacturer's standard baked finish.
- F. Component Color: Provide rails, cords, ladders, and exposed-to-view metal and plastic matching or coordinating with slat color, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install horizontal louver blinds level and plumb and aligned with adjacent units according to manufacturer's written instructions, and located so exterior slat edges in any position are not closer than 2 inches to interior face of glass. Install intermediate support as required to prevent deflection in headrail. Allow clearances between adjacent blinds and for operating glazed opening's operation hardware if any.
- B. Head Mounted: Install headrail on face of opening head.
- C. Adjust horizontal louver blinds to operate smoothly, easily, safely, and free of binding or malfunction throughout entire operational range.

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- D. Clean horizontal louver blind surfaces after installation, according to manufacturer's written instructions.

END OF SECTION 12491

SECTION 13125 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel framing.

1.2 SUBMITTALS

- A. Product Data: For each type of metal building system component.
- B. Shop Drawings: For metal building system components. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.
- D. Delegated-Design Submittal: For metal building systems indicated to comply with performance requirements and design criteria, including analysis data and calculations signed and sealed by the qualified professional engineer licensed to practice in Alaska responsible for their preparation.
- E. Welding certificates.
- F. Metal Building System Certificates: For each type of metal building system, from manufacturer.
1. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:
 - a. Name and location of Project.
 - b. Order number.
 - c. Name of manufacturer.
 - d. Name of Contractor.
 - e. Building dimensions including width, length, height, and roof slope.
 - f. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
 - g. Governing building code and year of edition.
 - h. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
 - i. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
 - j. Building-Use Category: Indicate category of building use and its effect on load importance factors.

- k. AISC Certification for Category MB: Include statement that metal building system and components were designed and produced in an AISC-Certified Facility by an AISC-Certified Manufacturer.
- G. Material test reports.
- H. Source quality-control reports.
- I. Field quality-control reports.
- J. Maintenance data.
- K. Warranties: Sample of special warranties.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer and member of MBMA.
 - 1. AISC Certification for Category MB: An AISC-Certified Manufacturer that designs and produces metal building systems and components in an AISC-Certified Facility.
 - 2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer licensed to practice in Alaska.
- B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."
- D. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings," for design requirements and allowable stresses.
- E. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.
- F. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A&S Building Systems, Inc.; Division of NCI Building Systems, L.P.
 - 2. Alliance Steel, Inc.

3. American Buildings Company; Division of Magnatrax Corp.
4. American Steel Building Co., Inc.
5. BC Steel Buildings, Inc.
6. Behlen Mfg. Co.
7. Bigbee Steel Buildings, Inc.
8. Butler Manufacturing Company; a BlueScope Steel company.
9. CBC Steel Buildings; Division of Magnatrax Corp.
10. Ceco Building Systems; Division of NCI Building Systems, L.P.
11. Chief Buildings; Division of Chief Industries, Inc.
12. Elite Structures, Inc.
13. Garco Building Systems; Division of NCI Building Systems, L.P.
14. Gulf States Manufacturers, Inc.; Division of Magnatrax Corp.
15. Inland Buildings; Subsidiary of Behlen Mfg. Co.
16. Kirby Building Systems; Division of Magnatrax Corp.
17. Mesco Building Solutions; Division of NCI Building Systems, L.P.
18. Metallic Building Company; Division of NCI Building Systems, L.P.
19. Metco Metal Supply.
20. Mid-West Steel Building Company; Division of NCI Building Systems, L.P.
21. Nucor Building Systems.
22. Oakland Metal Buildings, Inc.
23. Olympia Steel Building Systems.
24. Package Industries, Inc.
25. Pinnacle Structures, Inc.
26. Robertson Building Systems; an NCI company.
27. Ruffin Building Systems, Inc.
28. Schulte Building Systems, LLP.
29. Spirco Manufacturing.
30. Star Building Systems; an NCI company.
31. Tyler Building Systems, L.P.
32. USA, Inc.
33. VP Buildings; a United Dominion company.
34. Vulcan Steel Structures, Inc.
35. Whirlwind Building Systems.

2.2 METAL BUILDING SYSTEM PERFORMANCE

- A. Delegated Design: Design metal building system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Metal building systems shall be designed according to procedures in MBMA's "Metal Building Systems Manual."
 1. Design Loads: As indicated on Drawings.
 2. Design Loads: As required by ASCE 7 and IBC 2006.
 3. Deflection Limits: Design metal building system assemblies to withstand design loads with deflections no greater than the following:
 - a. Purlins and Rafters: Vertical deflection of 1/240 of the span.
 - b. Girts: Horizontal deflection of 1/180 of the span.

- c. Metal Roof Panels: Vertical deflection of 1/240 of the span.
 - d. Metal Wall Panels: Horizontal deflection of 1/180 of the span.
 - e. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
4. Drift Limits: Engineer building structure to withstand design loads with drift limits no greater than the following:
- a. Lateral Drift: Maximum of .020 of the building height. Where the lateral load resisting system consists only of moment frames, lateral drift shall not exceed .020/p of the building height, where p is the redundancy factor.
5. Metal panel assemblies shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated according to ASTM E 1592.
- C. Seismic Performance: Metal building systems shall withstand the effects of earthquake motions determined according to ASCE 7 and IBC 2006.
- D. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
- 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.3 STRUCTURAL-STEEL FRAMING

- A. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafter, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.
- 1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly.
 - 2. Frame Configuration: Per contract documents.
 - 3. Exterior Column Type: Uniform depth.
 - 4. Rafter Type: Uniform depth.
- B. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly.
- C. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating.

- D. Bolts: Provide plain-finish bolts for structural-framing components that are primed or finish painted. Provide zinc-plated or hot-dip galvanized bolts for structural-framing components that are galvanized.
- E. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

2.4 ROOF ASSEMBLY

- A. Roof assembly shall consist of the following materials:
 - 1. Zinc-coated (galvanized, ASTM A653, Grade 33, G90), 1-1/2" metal deck over structural roof framing. The metal deck shall be capable of supporting the specified design loads and applicable dead loads.
 - a. Metal deck shall be non-composite type deck without top flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck in Steel Deck Institute Publication No. 30.
 - b. Deck shall be minimum two span condition with interlocking side laps.

2.5 ACCESSORIES

- A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.
 - 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.

2.6 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to evaluate product.
- B. Special Inspector: Owner will engage a qualified special inspector to perform the following tests and inspections and to submit reports. Special inspector will verify that manufacturer maintains detailed fabrication and quality-control procedures and will review the completeness and adequacy of those procedures to perform the Work.
 - 1. Special inspections will not be required if fabrication is performed by manufacturer registered and approved by authorities having jurisdiction to perform such Work without special inspection. Approval shall be based upon review of the fabricator's written procedural and quality control manuals and periodic auditing of fabrication practices by an approved special inspection agency.
 - a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

- C. Testing: Test and inspect shop connections for metal buildings according to the following:
 - 1. Bolted Connections: Shop-bolted connections shall be inspected according to requirements of Chapter 17 in 2006 IBC and RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - 2. Welded Connections: shop-welded connections shall be tested and inspected as required in the Statement of Special Inspections.
- D. Product will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports. See Statement of Special Inspections.

2.7 FABRICATION

- A. General: Design components and field connections required for erection to permit easy assembly.
 - 1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
 - 2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.
- B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.
- C. Primary Framing: Shop fabricate framing components to size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.
- D. Secondary Framing: Shop fabricate framing components to size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.
- E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

PART 3 - EXECUTION

3.1 ERECTION OF STRUCTURAL FRAMING

- A. Erect metal building system according to manufacturer's written erection instructions and erection drawings.

- B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.
- C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.
- D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.
- F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.
 - 1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for bolt type and joint type specified.
 - a. Joint Type: Snug tightened or pretensioned.
- G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.
 - 1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
 - 2. Locate and space wall girts to suit openings such as doors and windows.
 - 3. Locate canopy framing as indicated.
 - 4. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.
- H. Steel Joists (if applicable): Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders," joist manufacturer's written instructions, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.

2. Space, adjust, and align joists accurately in location before permanently fastening.
 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
 4. Bolt joists to supporting steel framework using carbon-steel bolts unless high-strength structural bolts are required by the manufacturer.
 5. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
 6. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.
- I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.
1. Tighten rod and cable bracing to avoid sag.
 2. Locate interior end-bay bracing only where indicated.
- J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.
- K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.2 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. See Statement of Special Inspections for special inspection requirements.
- D. Tests and Inspections:
1. High-Strength, Field-Bolted Connections: Connections shall be tested and inspected during installation according to requirements of Chapter 17 in 2006 IBC and RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 2. Welded Connections: field-welded connections shall be tested and inspected as required in the Statement of Special Inspections.
- E. Product will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports. See Statement of Special Inspections.

END OF SECTION 13125

SECTION 13720 – ACCESS CONTROL SYSTEM

PART 1- GENERAL

1.1 SUMMARY

- A. This Section includes proximity card readers, motion detectors and associated components.

1.2 DEFINITIONS

- A. ES: Electric door strike
- B. PROX: Proximity

1.3 SYSTEM DESCRIPTION

- A. The access control system's primary function shall be to regulate access through specific doors, gates or barriers during non-business hours during the work week. It shall also have the provision of capturing cardholder images and producing access cards used to provide this access. The system shall use a single seamlessly integrated database for both its access control and badging functionality. This integration shall be provided under one operating environment. The system's interface, database, and other functionalities shall integrate with the existing access control system at the CBJ MIS Headquarters at City Hall.
- B. The system must be a Millennium Expert version. No substitutions will be accepted.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including installation instructions.
- B. Operating and Maintenance Instructions: Submit manufacturer's operating and maintenance instructions..
- C. Warranty: Submit manufacturer's standard warranty.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Responsible for all components.
 - 2. Continuously engaged in electronic access control system construction with a minimum of 10 years successful experience.

3. Able to demonstrate successful performance on comparable projects.
4. Responsible for system design, including:
 - a. Preparation of engineering and production documentation.
 - b. Development of testing program and interpretation of test results.
5. Design and Manufacturing Process: ISO 9001 certified.
6. Capability of providing manufacturer-employed field service personnel for installation assistance as required.
7. Capability of providing 24-hour, 7 days per week technical service assistance through a toll free telephone number after acceptance of work by the Owner.
8. Capability of providing manufacturer-employed field service personnel for technical service and maintenance after acceptance of work by the Owner.

B. Installer Qualifications:

1. Trained/Certified in installation and service by the manufacturer.
2. Must have a minimum of 2 years experience with the product as a certified installation and service company.
3. Approved and in good standing with the manufacturer.
4. Must maintain a service facility in the same community as the project location.
5. Must maintain a parts inventory of the commonly used system components.

1.6 DELIVERY, STORAGE & HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials indoors, in a clean, dry area in accordance with manufacturer's instructions.
- C. Handling: Protect materials and finishes during handling and installation to prevent damage.

1.7 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 1. Section 01810: Testing, Commissioning, and Training

PART 2- PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Millenium Group, Inc.

2.2 EQUIPMENT

- A. On-Line Electronic Access Control System: Millenium Expert.
 - 1. System shall have capability to perform:
 - a. Access control.
 - b. Alarm monitoring.
 - c. Identification badging.
 - d. Mustering
 - e. Scheduling actions
 - f. Reports
 - g. Programmable relay control.
 - h. View events in real time.
 - i. Print selected events in real time.
 - j. Elevator control.
 - k. Controlled by a computer
 - l. UL 294 listed
- B. Software Design:
 - 1. Native 32-bit, multi-tasking and multi-threaded, running under Microsoft Windows 98SE or above.
 - 2. Use a GUI (Graphical User Interface) based upon Windows standards, have extensive on-line help, and provide familiar icon-driven, tabbed dialog menu options.
 - 3. Perform network communications tasks via a separate integrated application running in background.
 - 4. Alarm monitoring, alarm editing, and setup applications shall require operator logon to function.
- C. Identification Badge Software:
 - 1. Include totally integrated identification badging, utilizing same database as access control system. No import or export shall be necessary. Can be added at any time with no database conversion necessary.
 - 2. Provide complete card layout capabilities, including graphic file import capability for all standard formats, and providing "drag and drop" element placement. Portrait and landscape card types in any dimensions shall be supported.
 - 3. Provide ability to design and print both sides of a card using suitable printers.
 - 4. Provide ability to print any selected database fields on card.
 - 5. Support Twain compatible devices for image capture.
 - 6. Support batch printing of badges.

7. Support encoding of any or all of 3 high or low Coercivity magnetic tracks, using suitable printers or encoders, from selected database fields.
8. Support fingerprint, bar code, and signature using suitable options.

D. Operators Software:

1. Limit system operator by default operator levels.
2. Capability of individual operator passwords for logging on.
3. Capability of programmable operator levels. These levels shall be fully programmable as to menu items and functions available to an operator.
4. Provide an automatic operator logoff delay.
5. Require a logon ID different from operator name to maintain network security.

E. Database Software:

1. Support ODBC standard and be supplied with a compatible database.
2. Supplied with a database management application to allow archiving of history, database repair functions, and import/export.
3. Support near-real-time import of data, and be arranged to support scheduling options for unattended operation.
4. Support automatic update of user access rights as a result of import process.
5. Allow for a unique industry standard ISO card number to be generated on demand as part of import process.
6. Protect each database by a specially generated unique password known only internally in software.

F. Alarm Monitoring Software:

1. Support a minimum of 4 supervised alarm inputs per door controller with time zone disable feature, and a programmable shunt delay timer from 0 to 255 seconds.
2. Support 3 additional non-supervised alarm inputs per door controller.
3. Provide a forced-door entry with an ajar alarm. Forced-door alarm shall have a shunt delay timer of 0 to 255 seconds. Ajar alarm shall have a programmable delay timer of 1 to 255 minutes.
4. Support adding name of alarm in a field minimum of 19 characters.
5. Support prioritizing of alarms to 99 levels.
6. Support linking specific alarms to relay control devices.
7. Include a graphical alarm editing application that shall allow a user to define alarms including graphical maps. Animated icons shall be placed on maps to indicate standard alarm types such as fire and break-in. Four levels of zoom shall be provided for each alarm.
8. Require acknowledgment text so personnel monitoring alarms shall provide response information.
9. Include an alarm monitor application separate from main software, which shall display alarms graphically in priority with which they were programmed. Application shall be able to be run from any workstation.
10. Provide alarm monitor with capability to display a user portrait in response to valid or invalid access attempts.
11. Provide alarm monitor with support for standard sound cards and .wav files so user defined sounds can be played for alarms.
12. Log-off required to quit alarm monitor.
13. Programmable requests for incident reports.

14. Support up to 4 floor maps per input per door controller.

G. Client (Guard) Tour Software:

1. Include a guard or client tour application, which can be run from any workstation on network.
2. Provide client tour application for up to 100 tours, with a maximum of 96 intervals each.
3. Types of Tours Available:
 - a. Global: Assigned to any individual card holder at time tour is selected.
 - b. Individual: Assigned to a card holder at time of creation.
4. Allow for selective filtering at device level, so as to allow multiple workstations to run different tours.

H. System Hardware:

1. System shall be able to be configured from 1 to 100 access readers for each site control unit.
2. Controllers shall have capacity of memory support, including real-time clock for a minimum of 24 hours, in case of AC loss of power and battery backup is exhausted.
3. System shall use a fully-distributed architecture in which system alarms, access, relays, and elevator control shall continue to function in a normal mode without computer communications.
4. Site controller shall be able to communicate to computer via EIA standard RS-232, RS-485, dial-up modem, lease line, fiber optics, wireless Spread Spectrum modem, or with use of a Site Ethernet Interface, via TCP/IP protocol.
5. Site controller shall have a local relay to monitor status of communications with door control units. In case of device failure relay will open, providing a means of triggering an external monitoring device.
6. Site, door, relay, and elevator controller features shall have capability to be field upgraded by a firmware change. Such firmware upgrades shall be offered as needed to registered users on an exchange basis, labor not included.
7. Door controller shall support any Wiegand standard based readers in any bit format up to 50 total; bit patterns fully programmable within software.
8. Door controller shall read Dallas touch chip format directly without use of accessory devices.
9. Door controller shall have ability to read Marlok™ metal keys and key readers without use of interface devices.
10. Example supported reader types include but are not limited to: Wiegand, Mag stripe, Bar Code, Proximity, Dallas Touchkey, Keypad, Biometrics, combination keypad with Wiegand/Proximity/Magnetic stripe.
11. Door controller shall be able to be programmed for custom ABA formats from PC software, including ability to ignore user specified characters in format.
12. Door controller shall be programmable to accept either normal or inverted strobe signals from ABA format readers.
13. Same door controller shall be programmed for all access reader technologies as specified by means of PC software.
14. Site controller shall buffer last 2,000 events from door controllers when

- computer communications has been lost or terminated.
- 15. Each door controller shall buffer an additional 2,000 events when site controller buffer has filled.
- 16. All system controllers shall have a built-in tamper alarm to detect when a cover to controller is removed.
- 17. Door Controller:
 - a. Request to Exit input.
 - b. Single reader input configuration.
 - c. Located within 10 feet (3 m) of access reader.
 - d. Function at full capacity without communications to computer, and buffer events up to a maximum of 2,000 during this period.
 - e. Continue to function on battery backup at a minimum of 9 V DC.
- 18. Door and relay controller shall have Form C dry contact configuration.
- 19. Door and relay controller shall have relays with a minimum current rating of 24 V DC at 2 A with solid-state automatically resettable over current protection for contacts.
- 20. Door controller shall have a relay that can be programmed by software for: Valid User, Auto Activate, First User Auto Activate, Any User, Rejected User, or Alarm Options.
- 21. Relay controller shall have relays that can be configured by software for Time Zone Activation, Timed Activation, Timed Released, First Event Activation, and First Event Released.
- 22. Relay on door controller shall have a programmable timer and settings in software for strike and magnetic lock operation.
- 23. Door and relay controller shall provide a dedicated tamper alarm to monitor opening of controller mounting boxes.
- 24. Site to door controller communication conform to EIA RS-485 for a recommended total cable length of 5,000 feet (1,524 m).
- 25. Power Supply:
 - a. Battery backup capable of providing power for system during temporary AC power outage.

J. System Access Readers/Cards:

- 1. Reader: See plans.
- 2. Cards: See plans.

K. Reader Interface Module (Door controller):

- 1. Description:
 - a. Designed to control a single access point.
 - b. Contains a real-time clock and sufficient memory to provide access control independent of main PC.
 - c. Transaction history shall be automatically buffered when not on line with PC.
 - d. Priority event buffer assures alarms are annunciated in a timely manner even if history buffer is full.
- 2. Power: 9 to 14 V DC, supplied by central power supply; 80 to 110 mA, depending upon reader technology. 225 mA additional required during unlock of Marlok rotating cylinder (7 seconds maximum). Accessory relays require additional 20 mA each.
- 3. Power Protection: Reverse polarity, over voltage, transient.

4. Reader Technologies Supported: Marlok key, Wiegand card (any bit format up to 50), ABA/ISO Track 2, proximity, keypad, combination reader/keypad, Dallas TouchKey, biometrics.
5. Reader Interfaces Supported: Marlok, clock/data, clock/data inverted, Dallas touch, Wiegand.
6. History Buffer: 2,000 transactions.
7. Priority Event Buffer: 100 transactions.
8. On-Board Memory and Clock Backup: 24 hours minimum.
9. Maximum Users Stored in Memory: 10,000.
10. Alarm Input Points: 7 total, 2-wire supervised (EOL resistor) including built-in door contact monitoring.
11. Alarm Input Monitoring Circuit: Analog to digital conversion.
12. Tamper Alarm: On-board switch.
13. Output Relays: 2 each with Form C contacts rated 2 A, 30 V.
14. Output Relay Contact Protection: Solid-state polymeric resettable.
15. Connectors: 5 mm plug-on screw terminal.
16. Address Switches: Rotary, direct-reading 00 to 99.
17. Communications: Multi-drop RS-485, proprietary protocol.
18. Operating Environment:
 - a. Between 14 degrees F and 104 degrees F (-10 degrees C and 40 degrees C).
 - b. Less than 90 percent noncondensing humidity.
19. Dimensions, Mounted in Back Box: 10-1/2 inches high x 4-3/4 inches wide x 1-3/4 inches deep (267 mm high x 121 mm wide x 44 mm deep).
20. Weight, Mounted in Back Box: 5.0 pounds (2.3 kg).

L. Site Controller:

1. Description:
 - a. Designed to control a maximum of 100 door controllers and a maximum of 10 relay controllers.
 - b. Normally used for a single site or building, contains a real-time clock and sufficient memory to supervise site.
 - c. Maximum of 1,000 site controllers can be addressed in a system.
 - d. Transaction history is automatically buffered when not on line with PC.
 - e. Priority event buffer assures alarms are annunciated in a timely manner even if history buffer is full.
 - f. On-board switches select operational modes.
2. Power: 9 to 14 V DC, supplied by central power supply; 50 mA standby, 90 mA maximum.
3. Power Protection: Reverse polarity, over voltage, transient.
4. PC to SCU Communications Interface: RS-232, RS-485 4-wire, or TCP/IP.
5. SCU to DCD Communications Interface: RS-485 multi-drop 2-wire.
6. Modem Support: Hayes AT command set, 9,600 baud or greater.
7. Supervisory Relay: Rated 2 A, 30 V Form C. Opens on-site fault.
8. History Buffer: 2,000 transactions.
9. Priority Event Buffer: 100 transactions.
10. On-Board Memory and Clock Backup: 24 hours minimum.
11. Alarms: Lost AC input.
12. Tamper Alarm: On-board switch.
13. Connectors: 5 mm screw terminal.

14. Address Switches: Rotary, direct-reading 000 to 999.
 15. Operating Environment:
 - a. Between 14 degrees F and 104 degrees F (-10 degrees C and 40 degrees C).
 - b. Less than 90 percent noncondensing humidity.
 16. Dimensions, Mounted in Back Box: 10-1/2 inches high x 4-3/4 inches wide x 1-3/4 inches deep (267 mm high x 121 mm wide x 44 mm deep).
 17. Weight, Mounted in Back Box: 5.0 pounds (2.3 kg).
- M. Power Supply:
1. Power: [120 V AC, 60 Hz, 2 A, unswitched] [240 V AC, 50 Hz, 1 A, unswitched (export)].
 2. Fuses: 2 A AC input slow-blow, 1 A AC input (export), 8 A (battery output protection).
 3. Output: 13.8 V DC nominal, 5 A maximum.
 4. Battery Backup: 2 gelled lead acid cell, 6 V DC, 8.0 Ah, supplied with power supply.
 5. Alarm Outputs: Cover tamper switch and AC or power supply failure (dry contacts).
- N. Site Ethernet Interface:
1. Description: Designed to provide communications between Millenium Windows PC and site control unit(s) by means of Ethernet networks utilizing TCP/IP protocol.
 2. Power: 12 to 15 V DC, supplied by either central power supply or auxiliary power supply; 800 mA maximum.
 3. IP Address Setting: Software through RS-232 port.
 4. Data Backup: Nonvolatile memory.
 5. Network Interface: 10/100 base T, AUI.
 6. SCU Interface: RS-232-C, 9,600 baud.
 7. Communications Protocol (Network): TCP/IP.
 8. Communications Protocol (SCU Interface): Proprietary.
 9. Operating Environment:
 - a. Between 32 degrees F and 104 degrees F (0 degrees C and 40 degrees C).
 - b. Less than 90 percent noncondensing humidity.
 10. Dimensions: 7 inches high x 6 inches wide x 1-1/4 inches deep (178 mm high x 152 mm wide x 32 mm deep).
 11. Weight: 2.0 pounds (0.9 kg).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine conditions for compliance with requirements for installation tolerances, power characteristics, and other conditions affecting performance of transient voltage surge suppressors. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Install electronic access control system in accordance with manufacturer's instructions.

- C. Install system at locations as indicated on the drawings.
- D. Provide door hardware per Architecture specifications. Provide door switches, electric strikes, door operators, power supplies, readers, panic bars, and associated electrical, request to exit devices, and all other hardware that is required to provide an operational access control system as shown on the plans and described in the specifications. Provide all wiring between components. Provide all system set up and programming.
- E. Install electrical wiring to on-line system components as specified in Section 16100.
- F. Use manufacturer's supplied hardware.
- G. Replace defective or damaged components as directed by the Architect.
- H. Furnish to the Owner all required keys and keycards.

3.2 GROUNDING

- A. Connect transient voltage suppression circuit in line-to-neutral configuration if a neutral conductor is available.
- B. Ground each transient voltage surge suppressor enclosure.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Test completed installation to verify each component of electronic access control system is properly installed and operating.

3.4 ADJUSTING

- A. Adjust electronic access control system as required to perform properly.
- B. Adjust locksets for smooth operation without binding.

3.5 CLEANING

- A. Clean surfaces in accordance with manufacturer's instructions.
- B. Use cleaners approved by manufacturer, as some cleaners may damage keylok/keyreaders.
- C. Do not use abrasive cleaners.

3.6 DEMONSTRATION

- A. Provide a maximum of 2 consecutive days of on-site service by manufacturer.
 - 1. Demonstrate system to Owner's personnel.
 - 2. Train Owner's personnel in proper operation and maintenance.

END OF SECTION 13720

SECTION 13915 – AUTOMATIC FIRE SUPPRESSION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes design, labor and material for providing complete sprinkler system consisting of a wet sprinkler system.
- B. Related Sections:
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 15050 – Basic Mechanical Requirements
 - 3. Section 15075 – Mechanical Systems Painting and Identification
 - 4. Section 16851 – Fire Alarm

1.2 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the most stringent requirements shall prevail.

<u>Reference</u>	<u>Title</u>
NFPA 13	Installation of Sprinkler Systems
FM Global	
Loss Prevention Data Sheets 2-8	Earthquake Bracing for Water Based Fire Protection
Loss Prevention Data Sheets 2-8N	Installation of Sprinkler Systems
UL	Underwriters Laboratories

1.3 SUBMITTALS

- A. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Qualification Data: For qualified Installer and professional engineer.
 - 2. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13 and FM Global Design Guides that have been approved by authorities having jurisdiction, including hydraulic and seismic calculations.
 - 3. Wiring Diagrams: For power, signal, and control wiring.
 - 4. Welding certificates.
 - 5. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 - 6. Field quality-control reports.
 - 7. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

- B. Submit product data on all items furnished, in compliance with Section 01300, Contractor Submittals

1.4 DELEGATED DESIGN

- A. Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Sprinkler system design area reduction method based on use of quick response sprinkler heads are not allowed.

1.5 SEISMIC PERFORMANCE:

- A. Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13, ASCE/SEI 7 and FM Global Loss Prevention Datasheets 2-8 "Earthquake Bracing for Water Based Fire Protection". In case of conflict between the documents, the most stringent requirements shall prevail.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
 - b. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
 - c. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of

sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

- A. Wet system piping: Black-Steel.
- B. All steel piping in this article shall be suitable for 175-psig minimum working pressure.
- C. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- D. Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- E. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
 - 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. Anvil International, Inc.
 - b. Corcoran Piping System Co.
 - c. National Fittings, Inc.
 - d. Shurjoint Piping Products.
 - e. Tyco Fire & Building Products LP.
 - f. Victaulic Company.
 - 2. Pressure Rating: 175 psig minimum.
 - a. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - b. AWWA C606 and UL 213 cover couplings in subparagraph below in NPS 3/4 to at least NPS 12 (DN 20 to at least DN 300).

- c. 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.
- K. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
 - 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. Victaulic Company.
 - b. Or approved equal.

2.2 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. 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.

2.3 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
- B. Ball Valves:
 - 1. Standard: UL 1091 except with ball instead of disc.
 - 2. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
 - 3. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 4. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.
- C. NRS Gate Valves:
 - 1. Standard: UL 262.
 - 2. Pressure Rating: 250 psig minimum.
 - 3. Body Material: Cast iron with indicator post flange.

4. Stem: Nonrising.
5. End Connections: Flanged or grooved.

D. Trim and Drain Valves:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.

2.4 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

B. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
2. Characteristics: Nominal 1/2-inch orifice with discharge coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

C. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Painted.

D. Special Coatings:

1. Corrosion-resistant paint.

E. 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.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.5 PRESSURE GAGES

A. Standard: UL 393.

- B. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- C. Pressure Gage Range: 0 to 250 psig minimum.
- D. Water System Piping Gage: Include "WATER".

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans indicate general location and arrangement of piping. Install piping connection. Connect piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 13 for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install alarm devices in piping systems.
- J. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13 for hanger materials.
- K. Install pressure gages on feed main, and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- L. Fill sprinkler system piping with water.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors.

- N. Install sleeve seals for piping penetrations of concrete walls and slabs. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- D. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- E. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- G. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints. Rolled groove joints are not allowed.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

3.4 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

3.5 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 16.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

END OF SECTION 13915

SECTION 15050 – BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work includes complete mechanical systems as indicated on the Drawings and as specified herein. Where the word "provide" is used, it means "furnish and install complete and ready for use." Provide supervision, labor, material, equipment, and machinery necessary to complete the mechanical systems. Provide finished work, tested and ready for operation.
- B. Related Sections:
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 01810 – Testing, Commissioning, and Training
 - 3. Section 13915 – Automatic Fire Suppression System
 - 4. All other sections in Division 15
 - 5. Division 16

1.2 REFERENCES

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the more stringent requirement shall prevail.

<u>Reference</u>	<u>Title</u>
AFBMA	Anti - Friction Bearing Manufacturers Association
AGA	American Gas Association
ANSI	American National Standards Institute
ASA	Acoustical Society of America
ASTM A-48, Class 25	Standards for Gray Cast Iron Castings
IEEE	Institute of Electrical and Electronic Engineers
FM	Factory Mutual
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NEMA MG1-12.35	Motors and Generators
NEMA-3R	Weatherproof and Ventilated Enclosures
NFPA	National Fire Protection Association
IBC	International Building Code
IFC	International Fire Code
IMC	International Mechanical Code
UPC	Uniform Plumbing Code
UL	Underwriter's Laboratories

1.3 QUALITY ASSURANCE

- A. References in technical sections to a particular organization's standards shall be in accordance with those standards unless more restrictive criteria is indicated in the technical section.
- B. Work and materials shall be in accordance with requirements of all applicable local codes, regulations and ordinances, the National Electrical Code, International Building Code, Uniform Plumbing Code, International Mechanical Code and International Fire Code (locally adopted edition), the latest standards of the NFPA International Fire Codes, and the rules and regulations of all other authorities having jurisdiction. Nothing in Drawings and Specifications shall be construed to permit work not in conformance with these codes, rules, and regulations.
- C. Where Drawings or Specifications call for material or construction of a better quality or more stringent requirements than required by the above-mentioned codes, rules and regulations, the provisions of the Specifications shall take precedence over requirements of the codes, rules and regulations.
- D. Furnish without extra charge additional material and labor when required for compliance with these codes, rules and regulations, even though the work may not be written in the Specifications or shown on the Drawings.
- E. Electrical motors, starters, controls, devices and wiring shall comply with standards of NEC and shall be UL listed or Factory Mutual Approved and so identified.

1.4 DRAWINGS

- A. Drawings are diagrammatic, indicating the general arrangement of systems and work, and do not attempt to show exact details, precise locations, or all offsets in piping and ductwork. Do not scale drawings.
- B. Follow drawings in laying out work and coordinate work with drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom. If space conditions appear inadequate, notify the Architect/Engineer before proceeding with the work. Make reasonable modifications in the work without extra cost as needed to prevent conflict with work of other trades and for proper execution of the work.

1.5 EQUIPMENT DEVIATIONS

- A. Specific manufacturers and model numbers are noted to indicate a standard of design and are not intended to be restrictive, unless specifically noted.
- B. Approval of alternative and/or substitute products will be considered under terms and conditions specified in specification Section 01300. It is the Contractor's responsibility to provide adequate information to the Architect/Engineer to determine whether a proposed substitute is an "equal" product.
- C. Provide design to any part of the work resulting from the use of equipment and material other than specified or shown on the Drawings. Obtain approval of design from the

Architect/Engineer. Design cost and additional construction cost resulting from the redesign shall be at the Contractor's expense.

1. A Structural Engineer licensed in the State of Alaska shall perform building structural design that may be needed as a result of departure from the basis of design.
2. Stamped and signed structural drawings and structural calculations of the structural design shall be submitted to the Architect/Engineer in accordance with Section 01300.

1.6 SHOP DRAWINGS AND SUBMITTAL DATA

A. For submittals:

1. Submit the manufacturer's installation and startup manual and forms as a part of the initial equipment submittal.
2. Submit manufacturer's operations manual.
3. Submittals that do not include the above documents will be rejected.

B. Check and verify field measurements and requirements. Submit in accordance with specification Section 01300 promptly, so as not to delay the work, all shop drawings, submittal data, and layout drawings listed below, checked and approved by the Contractor. Make corrections required by the Architect/Engineer and re-submit to the Architect/Engineer in accordance with specification Section 01300.

C. The shop drawings and submittal data for the material and equipment listed below shall be grouped into reasonable size packages for submission. Submittals shall be properly labeled indicating specific material or equipment for which it is to be used and the Specification section and paragraph number relating to the submitted item.

D. Review, approve and stamp shop drawings and submittal data before submission to the Project Representative. Notify the Architect/Engineer in writing of any deviation from the requirements of the Contract Documents.

E. Failure to submit shop drawings and submittal data in ample time for checking and review shall not entitle the Contractor to an extension of Contract time.

F. Submit shop drawings, submittal data and layout drawings on the following equipment listed below and as required by other sections of Division 15 specifications:

1. Air Handling Unit
2. Compressed Air Equipment
3. Exhaust Fans
4. Rooftop Equipment Locations and Penetrations
5. Electric Motors
6. Variable Frequency Drives
7. Piping
8. Fittings
9. Valves
10. Piping Specialties
11. Identification
12. Insulation

13. Ductwork and Accessories
14. Diffusers and Grilles
15. Air Filters
16. Vent Stacks

1.7 CODES AND STANDARDS

- A. Give necessary notices to obtain permits and pay taxes, fees and other costs, including utility connections or extensions for the work. File necessary plans, prepare documents and obtain necessary approvals of authorities having jurisdiction. Obtain required certificates of inspection for work and deliver to the Architect/Engineer before request for acceptance and final payment for the work.
- B. Comply with laws, ordinances, rules, regulations and lawful orders of any public authority bearing on the performance of the work. If the Contractor observes that any of the Contract Documents are at variance therewith in any respect, the Contractor shall promptly notify the Architect/Engineer in writing and any necessary changes shall be accomplished by appropriate modification. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to the Architect/Engineer, the Contractor shall assume full responsibility, and shall bear all costs.
- C. Material and equipment within the scope of the UL Testing Laboratory Service shall be listed by the Underwriters' Laboratories for the purpose for which they are used and shall bear their listing mark.
- D. If two or more referenced codes or construction standards for the same type of work are specified and conflict with one another, then the requirements that are more stringent shall apply.

1.8 COORDINATION

- A. Give full cooperation to other trades and furnish in writing to other trades, with copies to the Project Representative, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- B. Where mechanical work will be installed in close proximity to, or will interfere with work of other trades, assist in determining space conditions to make a satisfactory adjustment. If work is installed before coordinating with other trades, or if it causes any interference with work of other trades, make the necessary changes in the work to correct the conditions and bear all costs.
- C. Furnish to other trades necessary templates, patterns, setting plans and shop details for the proper installation of work and for the purpose of coordinating adjacent work.
- D. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work (see Section 01810). During the commissioning, coordinate with the commissioning agent and make all adjustments required to demonstrate systems function properly.

- E. Provide access doors/panels as required for access to mechanical components such as valves, dampers, and other elements needing maintenance.

1.9 PROTECTION

- A. Protect work and material from damage and be liable for damage.
- B. Be responsible for work and equipment until finally inspected, tested and accepted; protect work against theft, injury or damage; and carefully store material and equipment received on site which are not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.10 SCAFFOLDING, RIGGING AND HOISTING

- A. Provide ladders, scaffolding, rigging, hoisting and services necessary for delivery into the premises and erection of any equipment and apparatus and execution for the work. Remove same from premises when no longer required.

1.11 MATERIAL AND WORKMANSHIP

- A. Materials and equipment required for the work shall be new and shall be furnished, delivered, erected, installed, connected and finished in every detail; and shall be selected and arranged to fit properly into the building spaces.
- B. Furnish the services of an experienced superintendent, who shall be constantly in charge of the work.
- C. Materials and equipment shall be installed with the approval of the Architect/Engineer in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends and/or as stated in these specifications.

1.12 ELECTRICAL DEVICES

- A. All electrical motors, starters, controls and other devices furnished with mechanical systems shall be UL labeled or furnished with other certification satisfactory to the administrative authority. In addition, electrical components shall comply with Division 16 of these Specifications.
- B. Control Wiring Requirements:
 - 1. Per Division 16, all wire and cable (this includes control wire) installed within any City and Borough of Juneau facility shall be installed parallel or perpendicular to the building lines, whether in conduit or run as plenum cable.
 - 2. All control wire installed within walls shall be installed in conduit; this includes all drops to Thermostats and any sensor(s) connected to the control system.
 - 3. All control wire installed above hard ceilings shall be installed in conduit.
 - 4. All control wire installed above T-bar ceilings, where protected, may be installed as plenum cable without being installed in conduit.

- a. Control wire shall not be tied to or supported from conduit, sprinkler lines, water piping, lighting supports, ducting, other communication cabling installed within the ceiling space, any of the ceiling grid supports, or anything that will interfere with the maintenance of these systems.
 - b. All control wiring installation above suspended ceilings shall follow the requirements set forth in the National Electrical Code.
- 5. All control wire installed in spaces without a constructed ceiling (hard or T-Bar) or where exposed below a constructed ceiling, shall be installed in conduit, whether in a high bay or not.
 - 6. All conduit installed for HVAC control wire, shall be installed per the requirements specified in Division 16.

1.13 MOTORS AND CONTROLLERS

- A. Provide under this Division 15 all motors for all equipment specified herein. All controllers shall be provided by Division 16, Electrical Work, except those specifically indicated as being furnished under other sections of Division 15. All equipment and wiring shall conform to applicable sections of Division 16, Electrical Work.
- B. Power wiring for all motors and associated controllers other than wiring for automatic controls shall be furnished under Division 16, Electrical Work. Unless otherwise noted, power supply shall be 480 volts, 3-phase, 60 hertz for motors larger than 1/2 horsepower; and 120-volt, single phase, 60 hertz for 1/2 hp and smaller sizes. Control voltages shall be 120 volts or lower, single phase, 60 hertz, or direct current (DC), 30 volts or less unless shown otherwise on schedules.
- C. The horsepower ratings of electrical motors shown on the Drawings are based on engineering design calculations and the selection of specific manufacturer's catalog items of mechanical equipment. If the actual equipment to be furnished requires a different motor horsepower, any resulting changes in motor branch circuits and associated circuiting components must be included in the original contract bid. It shall be the full responsibility of the Contractor to coordinate the requirements of all equipment manufacturers with the Drawings.
- D. Alignment of all motors factory-coupled to equipment and all motors field-coupled to equipment shall be rechecked after all connections have been completed and after 48 hours of operation in designated service.
- E. All motors shall be designed and constructed in accordance with the latest edition of NEMA Standard MG1 and applicable portions of the NEC. Motors for use in hazardous locations, as defined in NEC Article 500, shall be approved for that classification by a recognized testing laboratory. For this Specification Section, the term "recognized" shall mean, having been listed as acceptable for at least 1 year by the authority having jurisdiction, as defined in the NEC.
- F. Submittal of motor data for acceptance shall include complete nameplate data in accordance with the applicable NEMA standards. Provide operating and maintenance information specified in Division 1.
- G. All equipment shall be designed and built for industrial service and be capable of delivering rated horsepower under the following applicable conditions:

1. 40 degrees C maximum ambient temperature.
 2. Voltage variations to ± 10 percent of nameplate rating.
 3. Frequency variations to ± 5 percent of nameplate rating.
 4. Combined voltage and frequency variations to ± 10 percent total, as long as frequency does not exceed ± 5 percent.
- H. Enclosures will be identified as follows:
1. ODP, open drip-proof
 2. WP, weather protected
 3. TEFC, totally enclosed, fan cooled
 4. TENV, totally enclosed, non-ventilated
- I. Motors located indoors shall be open drip-proof type. Motors located outdoors shall be weather protected, TEFC, or TENV with corrosion-resistant finish.
- J. ODP motors shall be designed such that particles of solid or liquid material falling at any angle from 0 to 15 degrees downward from the vertical shall not enter the ventilating openings or interfere with successful operation, as defined by NEMA standards.
- K. Weather-protected motors shall conform to the appropriate NEMA standards for enclosure type WPL.
- L. Motors used with variable frequency drives shall be inverter rated and premium efficiency.
- M. Motors used with variable frequency drives shall be equipped with Aegis, or approved equal, ground rings externally applied in factory or field.
- N. TEFC motors shall conform to the appropriate NEMA standards and shall be provided with drilled and tapped holes to drain all cavities within the motor. Motors with frame sizes 182 and larger shall have cast-in-place frames and end shields. Smaller frames shall be constructed of rolled steel with cast metal end shields. Motors with frames 286T or smaller shall have corrosion-resistant plugs in the drain holes. Motors with frame 324T or larger shall be provided with automatic breather-drain devices
- O. General Duty Motors: TEFC general duty motors shall have Class B insulation with a service factor of 1.15.
- P. Severe Duty Motors: TEFC severe duty motors shall have a Class F insulation with service factor of 1.15. Internal surfaces shall be coated with corrosive-resistant epoxy paint. Severe duty TEFC motors shall be Reliance Electric, SXT-XT, Marathon; or approved equal.
- Q. Explosion-proof Motors: The TEFC explosion-proof motors shall be UL listed for Class I, Division I, Group D hazardous atmospheres. The motors shall have a Class B insulation with a 1.15 service factor. UL approved breather/drain device shall be provided in the motor drain hole. The motors shall be provided with a frame temperature thermostat that meets the UL frame temperature limit code T2A (280 degree C). The thermostat shall contain an automatically reset, normally closed contact rated 2 amperes at 115 volt AC. The nameplate shall be marked with the temperature limit code.
- R. Electrical requirements for motors shall be as follows:

1. Service factor for single-phase motors shall be 1.0.
2. Service factor for three-phase motors shall be 1.15.
3. Time rating: All motors covered by this Section shall have continuous time ratings.
4. Torques: Motors shall meet, or exceed, the locked rotor and breakdown torques specified in NEMA Standards for NEMA Design B.
5. Currents: Locked rotor currents shall not exceed the values for NEMA Design B.
6. Protection: Current density and heating characteristics shall be such that the motors will not burn out if subjected to a maximum of 20-second stall at 6 times full-load current.
7. Rating: Motors shall not be required to operate at greater than their nameplate horsepower. Use of the service factor will not be allowed under conditions of rated voltage and frequency.
8. Insulation: All motors shall have insulation systems conforming to the requirements for NEMA Class B or higher.

S. Nameplates shall be as follows:

1. Motor nameplates shall be of a non-corrosive metal. Nameplates shall be engraved or stamped and shall be fastened to the motor frame with screws or drive pins of the same material.
2. Nameplates shall indicate clearly all the items of information enumerated in NEMA Standard MG1-0.37, MG1-10.38, or MG1-20.60, as applicable.
3. The Contractor shall coordinate the motor nameplate location so it is readily visible for inspection in the completed machine.

T. Mechanical requirements for motors shall be as follows:

1. Frame sizes: Frames shall conform to latest NEMA Standard MG1-11.31 for "T" frames, and all dimensions shall meet NEMA Standards insofar as they apply.
2. Shafts shall be in accordance with NEMA "T" or "TS" dimensions. Long shafts shall be suitable for belt, chain, or gear drive, within limits established by good industrial practice and documented by NEMA Standards MG1-14.42 and MG1-14.07. Short shafts shall be used for direct connection.
3. Wiring connection diagrams shall be permanently attached to the motor, either inside the conduit box or on the motor frame, in a location readable from the conduit box side.
4. External finish: Shall be corrosion resistant for outdoor operation.
5. Hardware: All bolts, screws, and other external hardware shall be treated for resistance to corrosion.
6. Motors for belt driven fans shall be mounted on adjustable cradles with lubricated screw or worm drive adjusters.

U. Insulation Check: The Owner may test the insulation resistance of the motor at any time after delivery of the motor to the jobsite or at any time during the warranty period. Tests for acceptability will be made using a 1,000-volt megohm meter (megger). Interpretations of test results for minimum acceptable values of insulation resistance will be made in accordance with IEEE No. 43. All deficiencies shall be corrected by the Contractor at no cost to The Owner.

V. Load Testing: The Owner may test a motor at any time after delivery of the motor to the jobsite or at any time during the warranty period to determine its ability to operate at nameplate current or less, and meet the load test requirements. If motors fail the test, the Contractor shall replace the motor at no cost to The Owner.

- W. Protective Coating: Before shipment, the shaft extension and any other external exposed metal parts of each motor shall be coated with removable rust preventive.
- X. Packaging: All motors shall be packed in Styrofoam or securely fastened to a hardwood skid or pallet for fork-truck handling and shall be covered for protection against dirt and moisture during transit and for short-time outdoor storage.

1.14 DRIVES AND GUARDS

- A. Belt Drives: Each motor which is not direct connected to its apparatus shall have grooved pulleys and V-belts designed for 125 percent of the full rated horsepower of the motor. Apparatus that starts fully loaded shall have belts designed for 150 percent of the full rated horsepower. Belts shall not jump or squeal or slip at high speed. Motors and driven apparatus shall be secured to a common base in a manner which allows adjustment of belt tension and alignment.
- B. Motor pulleys shall be steel and of the manually adjusted variable-pitch type arranged to keep belts parallel throughout the entire adjustable range. At design speed, pulleys shall be set midway in adjustment ranges. Multiple belt drives requiring 3 or more belts shall not be of variable-speed type. Such drives shall be furnished with solid sheaves. Make allowance for one change of pulley sizes, both larger and smaller, to compensate for field conditions.
- C. Pulleys and bushings shall be dynamically balanced. Pulleys shall be separately mounted on their bushes by means of three pull-up grub or cap tightening screws. Bushings shall be key seated to the driver shafts.
- D. Each belt-driven unit shall be furnished with a complete set of spare belts. Spare belts shall be properly identified as to design, horsepower, speed, length, pulley size and use and shall be packaged and stored as specified for spare parts storage and marking. Where 2 or more belts are involved, matched sets of belts shall be provided.
- E. V-belt drives shall conform to NEMA Standard NGI-3.15.
- F. Guards shall be fabricated of 12-gage steel and expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Guards to meet OSHA requirements.
- G. Fully enclosed belt drive guards shall have trimmed openings at both shafts for tachometer readings, with motor shaft opening slotted to permit adjustment for belt take-up. Fabricate guard large enough to permit installation of 2-inch larger driven pulleys without alteration to the guard. Secure guards to the driven machines or to the foundations by heavy angle supports and anchor bolts. Do not secure braces or supports to motors. Do not bridge sound and vibration isolators with braces or supports.

1.15 CUTTING AND PATCHING

- A. Provide drilling, coring, cutting and patching necessary to install the work specified in this division. Patching shall match adjacent surfaces.

- B. No structural members shall be cut without the approval of the Architect/Engineer, and cutting shall be done in a manner directed by him. Do not damage or endanger any portion of the project or work of The Owner or any other separate contractor by drilling, coring, cutting, patching, excavating and backfilling.
- C. Inform the other subcontractors affected of requirements for cutting and patching.

1.16 MECHANICAL SYSTEMS OPERATING INSTRUCTIONS

- A. Upon completion of the work, furnish the necessary skilled labor and helpers for operating the systems and equipment for a period of three (3) days of eight (8) hours each, or as otherwise specified. During this period, instruct The Owner or its representative in the operation, adjustment and maintenance of all equipment furnished. Give at least forty-eight (48) hours notice to the Owner in advance of this period.

1.17 OPERATION AND MAINTENANCE MANUALS

- A. Upon completion of the work and prior to acceptance of the mechanical work, prepare O&M manuals describing the requirements of mechanical equipment provided.
- B. Include in the manuals
 - 1. A table of contents with all contents listed in an orderly presentation
 - 2. Maintenance schedules and information
 - 3. Parts list
 - 4. Supplementary drawings and information where necessary to describe and itemize servicing including wiring diagrams and schematics
 - 5. Manufacturers' printed warranties and maintenance instructions specifically to the equipment installed
 - 6. Names, addresses and phone numbers of equipment suppliers
 - 7. Names, phone numbers and addresses of at least one service agency for each type or grouping of equipment.
- C. Data in manuals shall be neat, clean copies. Faxed material is not acceptable. Drawings shall be accordion-folded. Manufacturers' advertising literature or catalogs will not be acceptable for operating and maintenance instruction. Extraneous matter removed or neatly marked out.
- D. The front and spine of notebooks shall include the name of the building, CBJ Consolidated Public Works Facility, year of completion, the words "Mechanical Equipment," General Contractor's name, Mechanical Subcontractor's name, and Design Firm name.

1.18 RECORD DRAWINGS

- A. Provide record drawings of all buildings and plot plans, including changes resulting from addenda and change orders. Neatly illustrate all field adjustment and changes to show the work clearly in the actual locations as built.

1.19 CLEANING

- A. Promptly remove waste material and rubbish caused by the work. At Completion of the work, clean dirt and debris from the mechanical installation, including equipment, piping, ductwork and plumbing fixtures.
- B. Upon completion of the project and after cleaning is complete and before project is air balanced, provide clean air filters throughout.

1.20 WARRANTY

- A. All work, material and equipment to be free from defects. Refer to General Conditions for Warranty requirements. Correct all defects and failures occurring within one year from date of final acceptance without cost to The Owner except when such failure is due to neglect or carelessness by The Owner, as determined by the Architect/Engineer.
- B. The warranty disregards shorter time limits by any manufacturer of equipment provided.
- C. Make all necessary adjustments and corrections during first year of operation. The fact that the Architect/Engineer was present during any construction does not relieve the Contractor from responsibility for defects discovered after completion of the work.

1.21 SLEEVES, FLOOR AND CEILING PLATES

- A. All sleeves through floors and walls shall be standard weight galvanized steel pipe, flush with wall or ceiling, of size to accommodate the pipe or pipe and insulation, if insulated. Sleeves through outside walls and aboveground shall be caulked with epoxy grout except fire rated wall which shall be caulked in accordance with paragraph 1.22.

1.22 FIRE CAULKING/FIRE SAFING

- A. Provide Fire caulking/fire safing as required at all penetrations of rated walls. Fire stoppings shall be Dow Corning No. 2001 foam and NO. 2000 sealant, or approved equal.
- B. Provide caulking of all penetrations through walls or into adjacent spaces

1.23 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 & 15 Sections for all commissioning requirements related to the work of this Section.

- 1. Section 01810: Testing, Commissioning, and Training

1.24 START AND TESTING DOCUMENTATION

- A. All start-up, testing, and adjustment procedures, as well as results shall be fully documented and submitted for Owner's Representative and Commissioning Agent review.
- B. Provide a submittal of the proposed procedures and forms to document all required testing, start-up, and adjustments as well as the manufacturer's installation, start-up requirements, and forms, within 60 days of the equipment submittal approval. This shall be in the form of one book and indexed by equipment type. Also see Sections 01810.
- C. Within 14 days of completion of testing and start-up, provide a submittal of the completed approved testing/start-up forms with results and as-built procedures. This shall be in electronic format (pdf), by individual piece of equipment or system, for review and approval. Also see Sections 01810.
- D. Prior to final verification and demonstration of the equipment to the commissioning agent, provide a labeled CD with an index and all the start-up/testing documentation organized in a way that will allow ease of access and reference by facility staff. Each separate piece of equipment or system shall have a separate electronic file (pdf) on the CD. Also see Sections 01810.

PART 2 - PRODUCT (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 15050

SECTION 15060 – PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes complete (mechanical) pipe hanger and support systems as indicated on the drawings and as specified herein. Provide supervision, labor material, equipment, tools, and machinery necessary to complete the mechanical systems. Provide finished work, tested and ready for operation.
- B. Related Sections Include:
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 15050 – Basic Mechanical Requirements
 - 3. Section 15071 – Mechanical Vibration and Seismic Controls
 - 4. Section 15081 – Piping Insulation

1.2 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
SMACNA	Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems.
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
IBC	International Building Code
MSS	Manufacturer's Standardization Society

1.3 SUBMITTALS

- A. Product data and equipment supports including rods, pipe shields, clamps, springs, inserts, etc.
- B. Submit product data on all items furnished, in compliance with Section 01300.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide oversized hangers for all insulated piping to accommodate insulation thickness.

2.2 ACCEPTABLE MANUFACTURERS

A. Pipe hangers and supports:

1. Anvil
2. Unistrut
3. Superstrut
4. Approved equal.

2.3 STRUCTURAL ATTACHMENTS

- A. Strut type channel shall be electro-plated galvanized in office areas only. Hot dipped galvanized supports shall be provided in shop areas.
- B. Attachment into concrete: Concrete expansion anchors. Do not use powder driven inserts.
- C. Attachment to roof trusses: Manufactured beam clamps with retaining clip, Anvil Figure No. 87 or approved equal.
- D. Do not attach to under side of roof deck

2.4 INTERMEDIATE ATTACHMENTS

A. Hanger Rods:

1. Continuous threaded electroplated rod, do not use chain, wire or perforated strap.
2. Maximum hanger rod loading as follows:

Rod Size, <u>Diameter in Inches</u>	Maximum Load <u>Pounds</u>
3/8	610
1/2	1130

2.5 PIPE ATTACHMENTS

A. Pipe Hangers Clevises:

1. Steel, cast iron, and insulated copper tubing: Anvil No. 260, or approved equal.
2. Non-insulated copper tubing: 2-inch and smaller, adjustable ring Anvil No. 69, or approved equal.
3. Finish: Black for black steel pipe and cast iron pipe; galvanized for galvanized steel pipe; copper or plastic plated for copper pipe, or approved equal.

B. Pipe Clamps:

1. Vertical piping: Unistrut P-1100 channel and Unistrut P-1100 series pipe clamps, or approved equal. Copper pipe clamps with elastomer barrier for copper pipe. Plastic tape in lieu of elastomer barrier is not acceptable. Elastomer barrier shall be Unitstrut Unicushion, or approved equal.

2. Horizontal racked piping: Unistrut P-1109 series clamps for Unistrut channel pipe racks or approved equal. Electro-plated galvanized in office areas only. Hot dipped galvanized supports shall be provided in shop areas.

2.6 THERMAL PIPE HANGER SHIELD

A. General:

1. Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation.
2. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer.
3. The thermal shield shall be the same thickness as the piping system insulation specified.
4. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems.
5. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

B. Standard Shield:

1. Insulation:
 - a. Hydrous calcium silicate, high density, waterproof
 - b. Compressive strength: 100 psi average
 - c. Flexural strength: 75 psi average
 - d. K factor: 0.38 at 100 degrees F mean
 - e. Temperature range: 20 degrees F to 500 degrees F
2. Steel Jacket: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.
3. Connection: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

PART 3 - EXECUTION

3.1 HANGER SPACING FOR PIPING

- A. Horizontal Steel Pipe: Maximum hanger spacing and minimum hanger rod diameters as follows:

1/2 and 3/4 inch pipe	7-foot span	3/8-inch rod
1 and 1-1/4-inch pipe	7-foot span	3/8-inch rod
1-1/2-inch pipe	9-foot span	3/8-inch rod
2-inch pipe	10-foot span	3/8-inch rod
2-1/2 -inch pipe	11-foot span	1/2-inch rod

- B. Horizontal Copper Pipe: Maximum hanger spacing and minimum hanger rod diameters as follows:

1/2-inch pipe	5-foot span	3/8-inch rod
1-inch pipe	6-foot span	3/8-inch rod
1-1/4 -inch pipe	6-foot span	3/8-inch rod
1-1/2-inch pipe	8-foot span	3/8-inch rod

- C. Hangers and supports for other sizes and pipe materials not listed shall comply with MSS SP-58, SP-69, and SP-89.
- D. Provide additional hangers or supports at concentrated loads such as valves, to maintain alignment and prevent sagging.
- E. Vertical Piping Supports:
 - 1. Support piping at each roof penetration.
 - 2. Provide intermediate supports to prevent excessive pipe movement.

3.2 INSTALLATION OF PIPE HANGERS AND SUPPORTS

- A. Provide piping supports and hangers with a means of adjustment for leveling, grading of piping and cold spring movements.
- B. Provide sufficient hanger rod lengths to limit rod displacement from thermal expansion to 4 degrees from vertical.
- C. Size pipe hangers Clevises and clamps to pass around the pipe, except on piping with a vapor barrier on the insulation, then provide calcium silicate rigid inserts in accordance with Section 15081. Size rings and clamps to pass around the outside of the calcium silicate inserts.
- D. Install vertical piping supports to allow for pipe movement resulting from thermal expansion and contraction.
- E. Do not hang pipe from other pipe.
- F. Provide bored, drilled or reamed holes for all bolting to miscellaneous structural metals, frames or for mounts or supports. Flame cut, punched or hand-sawn holes will not be accepted.
- G. Install anchor bolts for all mechanical equipment and piping as required. Tightly fit and clamp base-supported equipment anchor bolts at all equipment support points. Provide locknuts where equipment is hung.

END OF SECTION 15060

SECTION 15071 – MECHANICAL VIBRATION AND SEISMIC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:

1. Mechanical Equipment Vibration Isolators
2. Seismic Protection of Piping and Equipment.

B. Related Sections Include:

1. Section 01300 – Contractor Submittals
2. Section 15050 – Basic Mechanical Requirements
3. Section 15060 – Pipe Hangers and Supports
4. Section 15140 – Pipe and Fittings
5. Section 15810 – Sheet Metal Ductwork

1.2 REFERENCED STANDARDS

- A.** This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
SMACNA	Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems.
IBC	International Building Code
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers

1.3 SUBMITTALS

A. Product data.

- B.** Submit product data on all items furnished, in compliance with Section 01300, Contractor Submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers:

1. Kinetics Peabody Noise Control,
2. Mason Industries,
3. Amber-Booth,
4. Vibrex,
5. Flexonics,
6. Approved equal.

2.2 MECHANICAL EQUIPMENT VIBRATION ISOLATORS

A. Rubber Pads:

1. Single layer Kinetics Type NPS or NPD.
2. Multi-layer Mason Industries Type WMW.
3. Multi-layer to receive leveling bolts Mason Industries Type WML.
4. Multi-layer requiring equipment anchoring Mason Industries Type WM.

B. Glass Fiber Pad:

1. Kinetics Type KIP.

C. Spring Hanger Kinetics SFH: Unhoused stable spring, with the ratio of horizontal to vertical spring constant not less than 1.0, and built-in leveling bolts. Provide springs with an additional overload capacity of 50 percent.

1. Spring isolators shall be free standing not damped type.
2. Springs shall be provided with acoustical friction pads at base.
3. Isolator springs shall be of adequate diameter for inherent stability without guide devices.

D. Seismic Snubber: Non-contact type welded steel Kinetics KSS, or approved equal.

E. Vibration isolators shall be provided on all rotating machinery as specified herein.

F. All mechanical equipment shall operate without objectionable noise and vibration.

G. All rotating equipment and the interconnected piping and ductwork shall be isolated to eliminate the transmission of objectionable noise and vibration.

H. Minimum deflection of isolators under normal operating conditions shall be not less than twice the maximum design deflection of the supporting structure of the building or as shown on Drawings.

PART 3 - EXECUTION

3.1 ISOLATION EFFICIENCY

- A. Isolate mechanical equipment in accordance with Table 48, Chapter 47, in the 2007 ASHRAE Handbook HVAC Applications.

1. Select isolators for floor-mounted or ceiling hung equipment from the "20-Foot Floor Span" column.
2. Select isolators for roof-mounted equipment from the "40-Foot Floor Span" column.
3. Select isolators for equipment mounted on grade support slabs from the "Grade Supported Slab" column.

3.2 SEISMIC PROTECTION OF PIPING

- A. Seismic Restraints: Provide seismic protection per IBC for all piping in accordance with the most current edition of the SMACNA publication "Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems".

3.3 SEISMIC PROTECTION OF EQUIPMENT

- A. Provide seismic protection for all equipment in accordance with the International Building Code.
- B. Support points on equipment shall be as designated and provided by the equipment manufacturer.
- C. Restraining devices shall be provided to prevent lateral movement during seismic events.

END OF SECTION 15071

SECTION 15075 – MECHANICAL SYSTEMS PAINTING AND IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:

1. Mechanical systems painting
2. Mechanical systems identification and flow arrows
3. Repainting of factory finished equipment

B. Related Sections Include:

1. Section 01300 – Contractor Submittals
2. Section 09912 – Interior Painting
3. Section 15050 – Basic Mechanical Requirements

1.2 REFERENCED STANDARDS

- A.** This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ANSI A13.1	Scheme for the Identification of Piping Systems

1.3 DEFINITIONS

- A.** "Concealed" work is defined as work installed within pipe shafts, duct chases, above furred or suspended ceilings, or otherwise built into the building and not exposed to view.
- B.** "Exposed" work is defined as work in shop areas, Mechanical Rooms, janitorial closets, on building rooftops, and all other areas not defined as "concealed."

1.4 SUBMITTALS

- A.** Provide the following prior to having plates engraved, labels printed, and valve and damper identification tags stamped.
- B.** A complete list of equipment, pipe, tubing, duct labels, and valve and damper tags.
- C.** A sample of each type of label showing sizing of letters and material.
- D.** Submit a copy of the valve identification tag chart before installing.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION PLATES

- A. Materials: 3-inch by 5-inch engraved plastic unless noted otherwise.
- B. Marking: Include the tag or Mark number indicated on the Drawings and the associated reference name.

2.2 VALVE AND DAMPER IDENTIFICATION TAGS

- A. General Description: numbered brass disc with brass chain for attachment to the valve.
- B. Numbering:
 - 1. Manual Valves: Engrave with numbers corresponding to the identification code shown on the piping drawings (e.g., CW-1, HW-4, HWR-2).
 - 2. Control Valves and Actuated Dampers: Engrave with numbers corresponding to the type and number of the control loop (e.g., TCV-1).
 - 3. Components and Devices: Engrave with numbers corresponding to the identification shown on the Drawings (e.g., PRV-1).

2.3 VALVE TAG CHART

- A. Assemble a valve tag chart indicating valve tag number, location of valve, service, and normal operating position of valve (open, closed, or throttling).
- B. Mount the chart in a suitable frame with a glass cover and present to the Owner.

2.4 PIPING AND DUCTWORK IDENTIFICATION LABELS

- A. Acceptable Manufacturers:
 - 1. Brady Corp.
 - 2. Seton Nameplate Corporation
 - 3. Or approved equal
- B. General Description:
 - 1. Vinyl or vinyl cloth with permanent, pressure-sensitive adhesive.
 - 2. Provide labels and adhesives of long lasting materials, resistant to moisture, oils, solvents, and weathering.
 - 3. Label color, lettering color, and lettering height shall conform to ANSI A13.1 requirements.
 - 4. Provide separate flow direction arrows that conform to the above criteria.

PART 3 - EXECUTION

3.1 PAINTING

- A. Paint all mechanical work, including piping and insulated surfaces, except where work is concealed in accordance with applicable Sections. Undamaged factory-finished equipment need not be repainted.
 - 1. Repaint finish damaged factory-finished equipment.
 - 2. Paint all visible surfaces behind grilles dull black.
 - 3. Clean grease, dirt, wax and scale from surfaces before painting.
 - 4. Insulation Surfaces:
 - a. 3 mils minimum dry film thickness; apply one coat of primer-sealer, and one coat of acrylic base paint and additional coats as required to obtain minimum dry film thickness.

3.2 EQUIPMENT IDENTIFICATION PLATES

- A. Installation:
 - 1. Install identification plates on all mechanical equipment.
 - 2. Provide ID tags on ceiling T bar wherein hidden equipment are mounted, including, but not limited to fire and smoke damper locations, remote sensors and damper locations, and shut-off valve above dropped ceiling. The tag shall have equipment ID number on 1"x3" plastic tag.
 - 3. Locate plates in a clearly visible location.
 - 4. Attach plates to equipment with stainless steel hardware or mastic to create a permanent bond.
 - 5. Valve and damper tags:
 - a. Attach tags to valve handle or yoke with brass chain.
 - b. Attach tags to damper handle or actuator with brass chain.
 - 6. Piping and ductwork identification labels:
 - a. Installation:
 - 1) Attach labels to lower quarter of piping and ducts on horizontal runs. Labels are to be visible when viewed from below.
 - 2) Install separate flow directional arrows with each label. Point flow indicator away from labels.
 - 3) Identify piping where it is not permanently concealed by the structure:
 - a) At each valve.
 - b) On both sides of wall and ceiling penetrations.
 - c) At roof penetrations
 - d) On each riser.
 - e) On each leg of tee.

- f) At connections to equipment.
- g) At least every 30 feet along continuous runs of exposed piping and piping in ceiling spaces that is accessible through ceiling tiles.

END OF SECTION 15075

SECTION 15110 – VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section specifies valves. Provide supervision, labor, material, equipment, and machinery necessary to provide and install valves for the mechanical systems. Provide finished work, tested and ready for operation.
- B. Related Sections Include:
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 01810 – Testing, Commissioning, and Training
 - 3. Section 15050 – Basic Mechanical Requirements
 - 4. Section 15075 – Mechanical Systems Painting and Identification
 - 5. Section 15081 – Piping Insulation

1.2 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
MSS	Manufacturers Standardization Society

1.3 SUBMITTALS

- A. Product data
 - 1. Submit product data on all items furnished, in compliance with Section 01300, Contractor Submittals.

1.4 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems function properly.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Testing

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Provide valves of same manufacturer throughout where possible.
- B. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

2.2 GENERAL

- A. Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves, unless indicated otherwise.
- B. Threaded connections for pipe sizes 2 inches and smaller.
- C. Flanged connections for pipe sizes 2 1/2 inch and larger.
- D. Solder or thread-to-solder adapters for copper tubing.

2.3 CHECK VALVES

- A. Horizontal 2-Inch and Smaller: Bronze body and disc, lift check, union bonnet, threaded ends, 150 psi, S.W.P., Milwaukee 544, or approved equal.
- B. Vertical 2-Inch and Smaller: Bronze body and bronze guided disc, lift check, threaded ends, 125 psi, S.W.P., Milwaukee 548, or approved equal.

2.4 BALL VALVES

- A. Manufacturers:
 - 1. Nibco.
 - 2. Stockham.
 - 3. Hammond.
- B. Construction, 3 inches and smaller: MSS SP-110, class 150, 200 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle, threaded ends.

2.5 GATE VALVES

- A. Manufacturers:
 - 1. Nibco.
 - 2. Milwaukee
 - 3. Red-White Valve corp.

- B. Up to and including 2-inches: MSS SP-80, class 125, bronze body, bronze trim, hand wheel, inside screw, solid wedge disc, threaded ends.
- C. 2-1/2 inches and larger: MSS SP-70, class 125, iron body, bronze seat, outside screw and yoke, hand wheel, solid wedge disc with brass seat rings, flanged ends. Provide chain wheel operators for valves 6 inches and larger, diameter, mounted over 8 feet above floor.

2.6 GLOBE VALVES

- A. Manufacturers:
 - 1. Nibco.
 - 2. Milwaukee
 - 3. Red-White Valve corp.
- B. Up to and including 2-inches: MSS SP-80, class 125, bronze body, bronze trim, hand wheel, bronze disc, threaded ends.
- C. 2-1/2 inches and larger: MSS SP-85, class 125, iron body, bronze seat, outside screw and yoke, hand wheel, renewable bronze plug-type disc, renewable seat, flanged ends.

2.7 RELIEF VALVES

- A. Pressure relief:
 - 1. Manufacturers:
 - a. Watts
 - b. Red-White Valve Corp.
 - 2. Construction: AGA Z21.22 certified, bronze body, Teflon seat, steel stem and springs, automatic, direct pressure actuated.
 - 3. Construction: Bronze body, Teflon seat, steel tem and springs, automatic, direct pressure actuated at 60 psi, UL listed for fuel oil, capacities ASME certified and labeled.
- B. Temperature and Pressure Relief:
 - 1. Manufacturers:
 - a. Watts
 - b. Red-White Valve Corp.
 - 2. Construction: AGA Z21.22 certified, bronze body, Teflon seat, steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME SEC IV certified and labeled. Size per ASME requirements.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all valves with stems upright or horizontal, not inverted.
- B. Install stem extensions for valve handles to clear insulation as needed.
- C. Valves shall be same size as connected piping unless shown otherwise.
- D. Install globe or ball valves for throttling, bypass, or manual flow control.
- E. Water pressure reducing valves to have pressure gages each side.
- F. Install drain valves at main shut-off valves, low points of piping, and at equipment. Use 3/4 inch ball valve with hose end adaptor.

3.2 SERVICE

- A. Flow direction: Use lift check valve for all sizes, valve to be rated for orientation of installation (horizontal/vertical).
- B. System drains: Use 3/4-inch drain valve for all piping sizes, unless indicated otherwise on the Drawings. Provide capped hose adapter where not indicated piped to drain.

3.3 ACCESS

- A. Install valves in accessible location to allow for ease of operation, maintenance, and removal/replacement.
- B. Valves installed in hard ceiling or in drywall shall have access doors with key lock for maintenance and operation access.

END OF SECTION 15110

SECTION 15122 – METERS AND GAGES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the meters and the gages that will be a part of this installation.
- B. Provide the following piping specialties:
 - 1. Pressure Gauges
 - 2. Thermometers
 - 3. Thermowells
 - 4. Portable Instrument Connections
 - 5. Pressure Regulators
- C. Related Sections:
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 01810 – Testing, Commissioning and Training
 - 3. Section 15050 – Basic Mechanical Requirements
 - 4. Section 15075 – Mechanical Systems Painting and Identification
 - 5. Section 15081 – Piping Insulation

1.2 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ANSI B1.1	Unified-Inch Screw Threads (UN and UNR Thread Form)
ANSI B18.2.2	Square and Hex Nuts (R1983)

1.3 SUBMITTALS

- A. Submit product data on all items furnished, in compliance with Section 01300, Submittals Procedures.

1.4 COORDINATION

- A. Furnish to other trades necessary templates, patterns, setting plans and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems function properly.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning and Training

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide specialty piping components in compliance with the requirements identified on the Drawings.
- B. Select component construction materials based on compatibility with the fluids identified in the design package.
 - 1. Pressure gauges (suitable for 200 deg. Process hot water)
 - a. Available Manufacturers:
 - 1) Terrice,
 - 2) March,
 - 3) Ashcroft,
 - 4) Approved equal.
 - b. 4-1/2-inch dial, cast aluminum case without back flange.
 - c. Scale shall be selected appropriate to the usage. For gauges serving boilers, the scale shall be a minimum of 1-1/2 times and a maximum of 3-1/2 times the relief valve setting in accordance with Section IV, HG 6 of the ASME Code.
 - d. Gauges for use on water services shall be installed with isolation ball valve with dampening snubber.
 - 2. Thermometers
 - a. Available Manufacturers:
 - 1) Terrice A00 Series,
 - 2) Marsh Y12 Series,
 - 3) Approved equal.
 - b. Industrial, adjustable angle, minimum length of 6-inch, aluminum case, red mercury type, separable socket.
 - c. Scale shall be selected appropriate to the usage or as indicated on the Drawings.

3. Thermowell

a. Available Manufacturers:

- 1) Terice,
- 2) Marsh,
- 3) Ashcroft
- 4) Approved equal.

b. Type: Stepped shank for use with insulated piping.

c. Material: Brass

d. Size: 3/4 inch NPT

e. Bore Diameter: .260-inch

4. Portable Instrument Connections

a. Available Manufacturers:

- 1) Sisco P/T Plugs
- 2) Approved equal.

b. Size: 1/2-inch size.

c. Rating: Valve core and body suitable for 300 degrees F.

d. Test Kit 2-2.5-2GA-2T complete.

- 1) Two (2) dial face gauge.
- 2) Two (2) stainless steel gauge adapter, size to match valve core/body.
- 3) Two (2) dial face thermometer.
- 4) Test kit to be turned over to Owner at the end of the project.

e. Select suitable temperature and pressure ranges for system requirements.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install meters, gauges, and test plugs in accordance with manufacturers' installation instructions and recommendations.
- B. Install indicating devices so they may be easily read from floor level and are readily accessible for maintenance and service.
- C. Provide isolation valves at each indicating device and specialty equipment for servicing.

END OF SECTION 15122

SECTION 15140 – PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes installation of piping and fittings required for piping and plumbing systems.
- B. Related Sections Include:
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 15050 – Basic Mechanical Requirements
 - 3. Section 15060 – Pipe Hangers and Supports
 - 4. Section 15071 – Mechanical Vibration and Seismic Controls
 - 5. Section 15075 – Mechanical Systems Painting and Identification
 - 6. Section 15081 – Piping Insulation
 - 7. Section 15110 – Valves

1.2 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ANSI B16.9	Factory-made wrought steel butt welding fittings
ANSI/ASME B16.22	Wrought copper alloy solder joint fittings
ANSI/ASME B16.3	American-made, malleable-iron threaded fittings
ANSI/ASME B16.5	American-made, pipe flanges and flanged fittings
ANSI/ASTM A53	Pipe, steel, black, welded and seamless
ASTM A234	American-made, seamless and welded wrought steel welding fittings
ASTM A888	Cast iron, no-hub soil pipe and fittings
ASTM B88	Seamless copper water tube
UPC	2006 Uniform Plumbing Code

1.3 SUBMITTALS

- A. Product data.
 - 1. Submit product data on all items furnished, in compliance with Section 01300, Contractor Submittals.
- B. Shop Drawings:
 - 1. Show layout of piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.

2. Piping indicated is schematic only. Size piping and design the actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment.

1.4 COORDINATION

- A. Coordinate layout and installation of piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- C. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Drain, Waste, and Vent Piping and Fittings, Belowground:
 1. Pipe (2-inches and larger): ASTM A 74, Cast iron.
 2. Fittings(2-inches and larger): ASTM A 74, Cast iron. Long sweep bends.
 3. Protective coating: Buried Steel pipe shall have Plexco applied polyethylene coating extruded on outside of pipe. Buried Steel Fittings shall have 10 mil polyethylene Scotchwrap "3M" wrap with adhesive applied to all exposed surfaces. Apply per manufacturer's recommendations.
- B. Drain, Waste, and Vent Piping and Fittings, Aboveground:
 1. Pipe (1-1/4 to 1-1/2-inches): ASTM B306, Copper drainage tube except roof drains shall be ASTM A 120, galvanized steel, schedule 40.
 2. Fittings (1-1/4 to 1-1/2-inches): ASTM B16.23, cast copper alloy solder drainage fittings except roof drains shall be ASTM A 47, galvanized malleable iron, 150 pound, threaded.
 3. Pipe (2-inches and larger): ASTM A 74, Cast iron, long sweep bends, standard weight, hub and spigot or no-hub, except roof drains shall be ASTM A 47, galvanized malleable iron, 150 pound, threaded.
 4. Fittings (2-inches and larger): ASTM A 74, Cast iron. Long sweep bends.
 5. No hub fittings shall be Clamp-all, or approved equal.
- C. Water Piping and Fittings, Belowground:
 1. Pipe (3-inches and smaller): ASTM B88, seamless copper water tube, type K.
 2. Fittings (3-inch and smaller): ANSI B16.22, Wrought copper and bronze solder joint pressure fittings.

3. Pipe (4-inches and larger): A21.51, ductile iron pipe, class 53, mechanical or Tyton joints.
4. Fittings (4-inches and larger): ANSI A21.10 cast iron fittings, mechanical or Tyton fittings, 125 pound.
5. Protective coating: Buried Steel pipe shall have Plexco applied polyethylene coating extruded on outside of pipe. Buried Steel Fittings shall have 10 mil polyethylene Scotchwrap "3M" wrap with adhesive applied to all exposed surfaces. Apply per manufacturer's recommendations.

D. Water Piping and Fittings, Aboveground:

1. Pipe (3-inches and smaller): ASTM B88, seamless copper water tube, type L.
2. Fittings (3-inches and smaller): ANSI B16.22, Wrought copper and bronze solder joint pressure fittings.
3. Pipe (4-inches and larger): A 53, steel, schedule 40, class 53, galvanized, flanged or grooved couplings.
4. Fittings (4-inches and larger): ANSI A21.10 cast iron fittings, flanged or grooved couplings, 125 pound.
5. Exposed Piping: Exposed hot and cold water lines at plumbing fixtures shall be chrome over nickel-plated brass.
6. Flanges: (3-inches and smaller): ANSI B16.24, bronze, 150 pound, ASME standard.
 - a. Bolts and Nuts: Square head machine bolts with heavy hex nuts, galvanized.
 - b. Gaskets: 1/16th inch, full faced, for potable water service.

E. Hydronic Piping and Fittings, Aboveground:

1. Pipe (3-inches and smaller): ASTM B88, seamless copper water tube, type L.
2. Fittings (3-inches and smaller): ANSI B16.22, Wrought copper and bronze solder joint pressure fittings.

F. Compressed Air Piping:

1. Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized steel.
2. Fittings: ASTM A47, galvanized malleable iron, 150 pound, threaded. Horizontal exposed pipe lengths 1-inch and larger shall be coupled with tee fittings having 3/4-inch plugged branch located on top side for future connections.

G. Tank Vents:

1. Pipe: ASTM A 53, Schedule 40.
2. Fittings: 150 lb fittings.

H. Unions

1. Copper tube, sweat, Nibco No. 733, Grinnell-ITT No. 9730, EPC No. 4733.
2. Steel pipe, threaded 2-inch and under, malleable-iron 250-lb. ground joint.
3. Dielectric unions, soldered to threaded 2-inch and below, flanged 2-1/2-inch and above. Select gasket for pressure and temperature range of service. Capitol Series CS or F, Epcos "Dielectric Union, or approved equal."

I. Pipe Seals

1. Fire stopping seals shall be USG Interiors, Inc. Thermafiber Safing insulation and Thermafiber Smoke Seal, or approved equal.

J. Escutcheon Rings

1. Escutcheon rings shall be chrome split ring type.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Keep openings in piping and ends of pipe closed during installation.
- B. Provide for expansion in piping systems with piping offsets.
- C. Change size in piping with reducing couplings; bushings not acceptable.
- D. Install all piping parallel with the building and other piping.
- E. Cut pipe accurately to measurement established on building and work into place without springing or forcing.
- F. Install piping concealed in finished rooms, unless indicated otherwise.
- G. Install exposed work neatly and workmanlike; run pipes parallel to the closest wall; maintain maximum headroom; avoid light fixtures.
- H. Correct piping leaks immediately; use new materials; leak-sealing compounds or peening not permitted.
- I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- J. Arrange piping to allow inspection and service. Install valves and specialties in accessible locations to allow for service and inspection.
- K. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- L. Hanger, support, and anchor products are specified in Section 15060, Pipe Hangers and Supports

3.2 THREADED PIPING JOINTS

- A. Ream all pipe to full diameter.

- B. Use non-Mercury thread sealant on all compressed air threaded joints, Loctite No. PSP 567, or approved equal.
- C. Use pipe dope or Teflon tape on male threads of all other threaded joints.
- D. Close nipples not permitted.
- E. Full cut threads and make up joints with no more than three threads exposed.
- F. Do not caulk threaded joints to stop leaks.

3.3 COPPER PIPING JOINTS

- A. Ream thoroughly to remove burrs.
- B. Polish contact surfaces of fittings and piping with emery cloth, sandpaper or steel brush, and wipe clean before fluxing male and female surfaces of joints.
- C. Steel wool not permitted for polishing.
- D. Take care to avoid burning of piping.
- E. Provide solder unions, ground joint or flanged joints where necessary for access to equipment.
- F. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent scale formation.

3.4 UNIONS

- A. Provide unions at all connections to equipment and where necessary to disconnect for repairs.
- B. Provide dielectric unions between dissimilar metals.

3.5 PIPE SEALS AND ESCUTCHEON RINGS

- A. At exterior walls, walls below grade and floor slabs on grade, provide water tight seal. Core drill round opening in existing concrete in accordance with seal manufacturer's recommendations. Install assembly to provide a penetration capable of withstanding a 20 psi differential pressure across the seal.
- B. At fire wall, floor and roof penetrations, seal annular space at pipes with fire stopping insulation and 2-inch minimum coating of smoke seal.
- C. Fill annular space at all other piping penetrations with fiberglass batt insulation to a compressed fit.
- D. Provide escutcheon rings for all exposed non-insulated pipes passing through walls, floors and ceilings.

3.6 PIPING SYSTEM TESTING

- A. Testing shall be done in conformance with the 2006 Uniform Plumbing Code (UPC).
- B. Notify the Architect twenty four (24) hours before each test.
- C. Water, Hydronic, and Water Non-potable Piping
 - 1. Upon completion of rough in, hydrostatic test piping system to 150 psig. Hold test for a minimum of four hours.
 - 2. If a portion of the piping system is to be concealed before finishing, this portion shall be tested separately.
 - 3. If test indicates a leak or defect, repair by remaking with new materials and retest.
- D. Compressed Air Piping
 - 1. Pressure test the compressed air system with compressed air or nitrogen at one and one half times the working pressure of the system. Hold test for a minimum of four hours.
 - 2. If test indicates a leak or defect, repair by remaking with new materials and retest.
- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Bleed air from fluids piping using manual air vents.

END OF SECTION 15140

SECTION 15185 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Separately coupled, in-line centrifugal pumps.

B. Related Sections

1. Section 01300 – Contractor Submittals
2. Section 01810 – Testing, Commissioning, and Training
3. Section 15050 – Basic Mechanical Requirements
4. Section 15071 – Mechanical Vibration and Seismic Controls
5. Section 15075 – Mechanical Systems Painting and Identification
6. Section 15975 – Direct Digital Controls

1.2 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

C. HI: Hydraulic Institute

1.3 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
- C. Wiring Diagrams: Power, signal, and control wiring.
- D. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal for each pump.

1.7 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 Sections for all commissioning requirements related to the work of this Section.
 - 1. 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL PUMPS (P-4, 5, 6)

- A. Available Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
 - 3. Grundfos.
 - 4. Or approved equal.
- B. Description: Factory-assembled and -tested, in-line type, close-coupled, single stage design for installation in vertical or horizontal position, and capable of being serviced without disturbing piping connections. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
 - 1. Casing: Cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
 - 2. Impeller: Bronze/brass, enclosed type, keyed and secured to the shaft by a locking capscrew or nut. Trim impeller to match specified performance.
 - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 - 4. Mechanical Seal: Ceramic seal seat and carbon seal ring, suitable for continuous operation at 225. A shaft sleeve shall completely cover the wetted area under the seal.
 - 5. Pump Bearings: Grease-lubricated ball bearings adequate for the maximum load of the motor.
- D. Motor: Single speed, with grease lubricated ball bearings, unless otherwise indicated; secure to mounting frame, with adjustable alignment. Comply with requirements in Section 15050.
- E. Capacities and Characteristics: See Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Install continuous-thread hanger rods and elastomeric hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Section 15071, Mechanical Vibration and Seismic Controls. Fabricate brackets or supports as required. Hanger and support materials are specified in Section 15060, Hangers and Supports.
- E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and elastomeric hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls." Hanger and support materials are specified in Division 15 Section "Hangers and Supports."

3.3 ALIGNMENT

- A. Comply with pump and coupling manufacturers' written instructions.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles with isolation valves.
- E. Install check valve and throttling valve on discharge side of pump as shown.
- F. Install Y-type strainer and shutoff valve on suction side of pumps.
- G. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
- H. Ground equipment according to Division 16 Section.
- I. Connect wiring according to Division 16 Section.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Assist in developing the final functional test procedures as specified in Sections 01810 and related sections.
 - 2. Provide authorized startup technician to perform functional performance testing as specified in Sections 01810 and related sections.
 - 3. Provide building commissioning support as specified in Sections 01810 and related sections.
 - 4. Complete installation and startup checks according to manufacturer's written instructions.
 - 5. Check piping connections for tightness.
 - 6. Clean strainers on suction piping.
 - 7. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 8. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 9. Start motor.
 - 10. Open discharge valve slowly.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 1.

END OF SECTION 15185

SECTION 15200 – CHEMICAL WATER TREATMENT

PART 1 GENERAL

1.01 SUMMARY

A. Water system cleaning and treatment for HVAC piping systems; including:

1. Cleaning of Heating Water piping systems.
2. Chemical feeder equipment.
3. Treatment for Heating Water systems.

B. Related Sections

1. Section 01300 – Contractor Submittals
2. Section 01810 – Testing, Commissioning, and Testing
3. Section 15050 – Basic Mechanical Requirements
4. Section 15122 – Meters and Gages
5. Section 15140 – Pipe and Fittings
6. Section 15519 – Electric Boiler
7. Section 15772 – Radiant Heating Piping

1.02 SUBMITTALS

- A. Include product data for all chemical treatment materials, chemicals, and equipment.**
- B. Provide operation and maintenance manual information to be included in operation and maintenance manual.**

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications:** Company specializing in manufacturing the products specified in this section with minimum ten years documented experience with local representatives with water analysis laboratories and full-time service personnel within a 50-mile radius of the site.
- B. Conform to applicable EPA code for addition of toxic, legally prohibited chemicals to building mechanical systems and for delivery to public sewage systems.**

1.04 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems function properly.**
- B. See the following Division 1 Sections for all commissioning requirements related to the work of this Section.**
1. 01810: Testing, Commissioning, and Training

1.05 MAINTENANCE SERVICE

- A. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.
- B. During the one-year service period described above, provide monthly technical service visits to perform field inspections and make water analyses on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit to the Project Representative.
- C. Provide laboratory and technical assistance services during warranty period.
- D. Include two 2-hour training courses for installation, care, maintenance, testing, and operation of water treatment systems. Arrange training schedule at start-up of systems.
- E. Provide sufficient chemicals for treatment and testing during warranty period.

PART 2 PRODUCTS

2.01 AVAILABLE MANUFACTURERS:

- A. Betz.
- B. CH2O.
- C. Nalco.
- D. Approved equal.

2.02 MATERIALS

- A. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
 - 2. Algaecide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite.
 - 3. Muriatic acid to remove mill scale.
- B. Closed System Treatment (Water):
 - 1. Sequestering agent to reduce deposits and adjust pH.
 - 2. Corrosion inhibitors; liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazone, low molecular weight polymers, phosphonates, sodium molybdate or sulphites.
 - 3. Conductivity enhancers; phosphates or phosphonates.

2.03 EQUIPMENT

- A. Chemical Pot Feeder: Five gallon cartridge type filter housing, quick opening cap suitable for working pressure of 175 pounds per square inch gage. Construct of materials that are impervious to the products being dispersed.

- B. Water Meter: Displacement type cold-water meter with sealed, tamper-proof magnetic drive, impulse contact register, single pole, double throw dry contact switch.

2.04 TEST EQUIPMENT

- A. Provide test cabinet with local and fluorescent light, capable of accommodating 4 to 10 ml zeroing titrating burettes and associated reagents.

PART 3 EXECUTION

3.01 PREPARATION

- A. Provide systems that are operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.

3.02 CLEANING SEQUENCE

- A. Add cleaner to closed systems at concentration as recommended by manufacturer.
- B. Add muriatic acid to the systems in the concentration recommended by the manufacturer, to remove mil scale. Flush system completely with water and test to assure that traces of muriatic acid have been removed. Repeat flushing as needed.
- C. Hot Water Heating Systems: Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum. Remove heat and circulate at 100 degrees F or less; drain systems as quickly as possible and refill with clean water. Circulate for six hours at design temperatures, then drain. Refill with clean water and repeat until system cleaner is removed.
- D. Use neutralizer agents on recommendation of system cleaner supplier.
- E. Remove, clean, and replace strainer screens.
- F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 HEATING WATER SYSTEMS TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install globe valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Subsequent to completion of cleaning and treatment, fill heating water systems with a 40% mixture of water and Propylene Glycol.

END OF SECTION

SECTION 15251 – GENERAL-SERVICE COMPRESSED-AIR EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes installation of equipment required for the compressed air system.

1. Provide the following piping specialties:

- a. Pressure Gauges
- b. Filters/Regulators/Lubricators (FRL)
- c. Quick Couplings
- d. Compressed Air Hose Assemblies

B. Related Sections Include:

- 1. Section 01300 – Contractor Submittals
- 2. Section 15050 - Basic Mechanical Requirements
- 3. Section 15060 – Pipe Hangers and Supports
- 4. Section 15071 - Mechanical Vibration and Seismic Controls
- 5. Section 15075 - Mechanical Paint and Identification
- 6. Section 15140 – Pipe and Fittings

1.2 REFERENCED STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ASME Section	American Society of Mechanical Engineers – Rules for Construction of Air Compressors and appurtenances

1.3 SUBMITTALS

A. Submit product data on all items furnished, in compliance with Section 01300, Contractor Submittals.

B. Provide submittals to include, but not limited to, the following:

- 1. Dimensional data, pressure ratings, and materials of construction for products.

C. Operation and Maintenance Manuals

1. Upon completion of the work and prior to acceptance of the mechanical work, prepare O&M manuals describing the requirements of mechanical equipment provided.
2. Include in the manuals:
 - a. A table of contents with all contents listed in an orderly presentation.
 - b. Maintenance schedules and information.
 - c. Parts list.
 - d. Supplementary drawings and information where necessary to describe and itemize servicing including wiring diagrams and schematics.
 - e. Manufacturers; printed warranties and maintenance instructions specifically to the equipment installed.
 - f. Names addresses and phone numbers of equipment suppliers.
 - g. Names phone number and addresses of at least one service agency for each type of grouping of equipment.
3. Data in manuals shall be neat, clean copies. Faxed material is not acceptable. Drawing shall be accordion-folded. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instruction. Extraneous matter shall be removed or neatly marked out.
4. The front and spine of notebooks shall include the name of the Project, year of completion, the words 'Mechanical Equipment'; General Contractor, Mechanical Subcontractor, Architect, and Mechanical Engineer of Record.

1.4 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During the commissioning, coordinate with the commissioning agent and make all adjustments required to demonstrate systems function properly.

1.5 WARRANTY

- A. All work, material, and equipment shall be free from defects. Correct all defects and failures occurring within one year from date of final acceptance without cost to the Owner except when such failure is due to neglect or carelessness by the Owner, as determined by the Architect.
- B. The warranty disregards shorter time limits by any manufacturer of equipment provided.
- C. Make all necessary adjustments and corrections during first year of operation. The fact that the Architect was present during any construction does not relieve the Contractor from responsibility for defects discovered after completion of the work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide specialty piping components in compliance with the requirements identified on the Drawings.

2.2 PRESSURE GAUGES:

- A. Manufacturer: Trerice No. 800 series, or approved equal.
 - 1. 4-1/2-inch dial, cast aluminum case without back flange.
 - a. Scale shall be selected appropriate to the usage.

2.3 FILTERS/REGULATORS/LUBRICATORS (FRL)

- A. Coalescing type filters with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated.
- B. Air-Line Pressure Regulator shall be as specified in paragraph 2.4
- C. Air-Line lubricator shall have a drip chamber and sight dome for observing oil drop entering airstream; with oil-feed adjustment screw and quick-release collar for easy bowl removal.

2.4 QUICK COUPLINGS

- A. Provide automatic-shutoff quick coupling assembly with locking-mechanism feature for quick connection and disconnection of compressed air hose at each air outlet drop.
- B. Straight-through brass body with O-ring seal and stainless-steel operating parts.
 - 1. Socket end shall have one-way valve and threaded inlet for connection to piping or threaded hose fitting.
 - 2. Plug end shall be straight-through type with serrated outlet for attaching hose.
- C. Refer to drawings for locations and sizes.

2.5 COMPRESSED AIR HOSE ASSEMBLIES

- A. Hose shall be reinforced double wire braid, CR-covered hose for compressed air service.
- B. Provide 3/8-inch hose size for CA system.
- C. Hose clamps shall be stainless-steel screw type bands. Use two clamps for each hose to fitting connection.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install specialties in accordance with manufacturers' installation instructions and recommendations.
- B. Install indicating devices so they may be easily read from floor level and are readily accessible for maintenance and service.

3.2 AIR VENTS

- A. Provide drain piping on automatic (electric) air vents and manual air vents. Route drain piping to nearest floor drain.
- B. Provide drain piping on automatic relief air vents. Terminate drain piping 6 inches above the floor.

3.3 FLEXIBLE CONNECTORS

- A. Installation shall not cause any change of position of equipment or piping that results in stress or misalignment of the equipment or piping. Fully anchor equipment and attached piping such that flexible connectors do not carry piping loads.
- B. Do not subject components to torsion during or after installation.
- C. Adequately support pipe sections in axial directions to force movement into flexible connector.

3.4 FILTER/REGULATOR/LUBRICATOR

- A. Provide at each compressed air drop and for fluid pumps.

END OF SECTION 15251

SECTION 15410 – PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes plumbing fixtures and related components.
- B. Related Sections
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 15050 – Basic Mechanical Requirements
 - 3. Section 15430 - Plumbing Specialties

1.2 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.3 SUBMITTALS

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.

- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Vitreous-China Fixtures: ASME A112.19.2M.
 - 3. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 - 4. Stainless Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 2. Faucet Hose: ASTM D 3901.
 - 3. Faucets: ASME A112.18.1M.
 - 4. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 5. Hose-Coupling Threads: ASME B1.20.7.
 - 6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 7. NSF Materials: NSF 61.
 - 8. Pipe Threads: ASME B1.20.1.
 - 9. Supply and Drain Fittings: ASME A112.18.1M.
 - 10. Sensor Actuated Faucets and Electrical Devices: UL 1951.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.
 - 2. Brass and Copper Supplies: ASME A112.18.1M.
 - 3. Manual-Operation Flushometers: ASSE 1037.
 - 4. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Floor Drains: ASME A112.21.1M.
 - 2. Grab Bars: ASTM F 446.
 - 3. Hose-Coupling Threads: ASME B1.20.7.
 - 4. Off-Floor Fixture Supports: ASME A112.6.1M.
 - 5. Pipe Threads: ASME B1.20.1.
 - 6. Plastic Toilet Seats: ANSI Z124.5.
 - 7. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 COORDINATION

- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

1.6 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 Sections for all commissioning requirements related to the work of this Section.
 - 1. 01810: General Commissioning Requirements

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. For fixture descriptions in other Part 2 paragraphs where the subparagraph titles "Available Products," and "Available Manufacturers," introduce a list of manufacturers and their products or manufacturers only, the following requirements apply for product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the products specified or an approved equal.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the manufacturers specified or an approved equal.

2.2 SINK FAUCETS

- A. Sink Faucet for Kitchen Sink S-1: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.
 - 1. Available Products:
 - a. Kohler K15171-FL
 - b. Or approved equal.
 - 2. Maximum Flow Rate: 2.2 gpm.
 - 3. Body Material: Cast brass.
 - 4. Finish: Polished chrome plate.
 - 5. Type: Single control kitchen faucet without spray.
 - 6. Mixing Valve: Single control.
 - 7. Centers: 8 inches.
 - 8. Mounting: Deck, concealed.
 - 9. Inlets: NPS 3/8 with ground joint connections.

10. Spout: 10" swing.
11. Spout Outlet: Pressure compensating aerator.
12. Operation: Manual.
13. Tempering Device: Not required.
14. ADA Compliant: Required.

B. Sink Faucet for Service Sink S-2: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Available Products:
 - a. Kohler K-8905
 - b. Or approved equal.

C. Trap for Service Sink S-2: 3-inch iron pipe.

1. Available Products:
 - a. Kohler K-6673
 - b. Or approved equal.

2.3 KITCHEN SINKS

A. Kitchen Sinks, S-1: Counter-mounting, stainless-steel fixture.

1. Available Products:
 - a. Kohler Co. Toccata K-3348-3
 - b. Or approved equal.
2. Overall Size: 25 by 22 inches.
3. Number of Compartments: One.
4. Compartment: With 3-1/2-inch outlet for disposer.
5. Sink Faucet: S-1.
6. Supplies: NPS 1/2 chrome-plated copper with stops.
7. Drain Piping: NPS 1-1/2 chrome-plated cast-brass trap, 0.045-inch- thick tubular brass waste to wall, and wall escutcheons.

2.4 SERVICE SINK

A. Service Sink, S-2:

1. Available Products:
 - a. Kohler Co. Bannon K-6714
 - b. Or approved equal
2. Overall size shall be 22 x 18 inches.
3. Sink shall be cast iron with acid resistant enamel finish.

4. Sink shall be single compartment with drilled back
5. Sink shall have a rim guard.

2.5 BOOT WASH FIXTURE

- A. Boot wash, BW-1: Single handle pressure balancing mixing hand wash unit with five foot flexible metal hose.
 1. Available products:
 - a. Symmons 1-25-FSB.
 - b. Or approved equal.
 2. Consumption: 1.5 gpm
 3. Supply size: 1/2" NPT female thread connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.
- D. Install wall-hanging fixtures with tubular waste piping attached to supports.
- E. Install counter-mounting fixtures in and attached to casework.
- F. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

- G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- I. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- J. Install toilet seats on water closets.
- K. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- L. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- M. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
- N. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Section 15140, Pipe and Fittings for escutcheons.
- O. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Section 07920, Joint Sealants for sealant and installation requirements.
- P. Install protective shielding guards on all exposed hot- and cold-water supplies and trap and drain piping complying with ADA requirements.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.
- E. Ground equipment.
 - 1. Ground equipment according to Section 16 specifications.

2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. In addition, do the following:
 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 2. Remove sediment and debris from drains.

END OF SECTION 15410

SECTION 15430 – PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide the following plumbing specialties:

1. Strainers
2. Hose Bibbs
3. Floor/Equipment Drains
4. Roof Drains
5. Trench Drains
6. Cleanouts
7. Reduced Pressure Backflow Preventers
8. Trap Seal Primer Valves
9. Thermostatic Mixing Valves
10. Eyewash Station
11. Escutcheons
12. Sleeve penetration Systems.
13. Miscellaneous Piping Specialties.

B. Related Sections:

1. Section 01300 – Contractor Submittals
2. Section 15050 – Basic Mechanical Requirements
3. Section 15075 – Mechanical Systems Painting and Identification
4. Section 15081 – Piping Insulation

1.2 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ASME	American Society of Mechanical Engineers
UPC	Uniform Plumbing Code

1.3 SUBMITTALS

- A. Product data
- B. Submit product data on all items furnished, in compliance with Section 01300, Contractor Submittals

1.4 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials, and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 & 15 Sections for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning and Training

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide specialty piping components in compliance with the requirements identified on the Drawings.

2.2 STRAINERS

- A. Available Manufacturers:
 - 1. Mueller,
 - 2. Conbraco (59 Series),
 - 3. Approved equal.
- B. Type: Y-pattern
- C. Material: Bronze
- D. Size range: 2 inch and less
- E. End Connections: NPT
- F. Screen Material: Stainless Steel
- G. Screen Perforation Size: 20 mesh
- H. ANSI pressure class: 200 psig at 150 deg F
- I. Maximum Operating Pressure: 350 deg F at 150 psig

2.3 HOSE BIBBS

- A. Available Manufacturers:
 - 1. Zurn

2. Approved equal.

B. Products:

1. HB-1: Anti-siphon, automatic draining wall hydrant for flush installation. Integral non-freeze backflow preventer, bronze casing, all bronze interior parts, non-turning operating rod with free-floating compression closure valve, replaceable bronze seat and seat washer, and combination 3/4" female or 1" male straight IP inlet. Nickel bronze box and hinged cover operating key lock and "WATER" cast on the cover. Basis of design product is ZURN Z1300.
2. HB-2: Exposed, non-freeze, wall faucet with exterior chrome finish, brass casing, all bronze interior parts, operating rod with free-floating compression closure valve, wall support, replaceable seat washer, combination 1/2" inch female solder inlet and 1/2" male IP inlet connection. 3/4" male hose connection.

2.4 FLOOR/EQUIPMENT DRAINS

A. Available Manufacturers:

1. Jay R. Smith
2. Jones Spec
3. Josam
4. Wade
5. Zurn
6. Approved equal.

B. Products:

1. FD-1: Square-top drain, coated cast iron body with bottom outlet, seepage slots, and cast iron hinged heavy-duty slotted grate. Basis of design product: Josam 37840. Size to match outlet pipe size as shown on drawings.
2. FD-2: "TYPE B" round adjustable light duty strainer top with square openings and secured gate. Basis of design product: ZURN Z400B. Size to match outlet pipe size as shown on drawings.

2.5 ROOF DRAINS

A. Available Manufacturers:

1. Josam
2. Approved equal.

B. Products:

1. Coated cast-iron roof drain, large polypropylene locking dome, non puncturing clamp ring with integral gravel stop, adjustable top with wide roof flange, large sump with anchor flange, bottom threaded connection. Basis of design product is Josam 21000 Series or 21010 Series

2.6 TRENCH DRAINS (TD-1)

A. Available Manufacturers:

1. ZURN
2. Approved equal.

B. Products:

1. 6-Inch wide modular trench drain system. Modular channel sections shall be made of FRP fiberglass, have interlocking ends, and a radiused bottom. Channel shall be provided with a 0.75% built-in slope. Channels shall be H-20 load rated. Grate shall be ductile iron, Class F DIN rated, and h-20 load rated. Basis of design product: ZURN Z-886 trench drain with DGE grate.

2.7 CLEANOUTS

A. General:

1. Same size as piping up to 4 inches and minimum of 4 inches for larger piping

B. Products:

1. Interior Floor Cleanouts (except vehicle drive areas): Coated cast iron floor cleanout, spigot or hubless connection, internal gasketed ABS cleanout plug, adjustable ABS housing, secured scoriated satin Nikolay top.
 - a. Concrete and resilient tile floor areas: Josam 56010 Series, or approved equal.
2. Exterior Floor Cleanouts (and interior vehicle drive areas): Coated cast iron floor cleanout, spigot or hubless connection, internal gasketed ABS cleanout plug, adjustable ABS housing, heavy-duty loose set scoriated round cast iron tractor cover.
 - a. Concrete areas: Josam 56050 Series, or approved equal.
3. Wall Cleanouts: Coated cast iron cleanout ferrule with no hub connection, bronze countersunk plug, and access cover. Josam Series 58900, or approved equal.

2.8 REDUCED PRESSURE BACKFLOW PREVENTORS

A. Available Manufacturers:

1. Febco,
2. Conbraco (40-200 series), complete with gate isolation valves.
3. Approved equal.

2.9 TRAP SEAL PRIMER VALVES

A. General: Supply-Type Trap Seal Primer Valves: ASSE 1018, water-supply-fed type, with the following characteristics:

B. Available Manufacturers:

1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Industries, Inc.; Drainage Products Div.
6. Zurn Industries, Inc.; Jonespec Div.
7. Approved equal.

- C. 125-psig minimum working pressure.
- D. Bronze body with atmospheric-vented drain chamber.
- E. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
- F. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
- G. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.10 THERMOSTATIC WATER MIXING VALVES

- A. General: ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body. Include check stop and union on hot- and cold-water-supply inlets, adjustable temperature setting, and thermometer.
 1. Type: Bimetal thermostat, operation and pressure rating 125 psig minimum.
 2. Type: Liquid-filled motor, operation and pressure rating 100 psig minimum.
- B. Available Manufacturers:
 1. Lawler Manufacturing Company, Inc.
 2. Leonard Valve Company.
 3. Mark Controls Corp.; Powers Process Controls.
 4. Symmons Industries, Inc.
 5. T & S Brass and Bronze Works, Inc.
 6. Approved equal
- C. Thermostatic Water Mixing Valves: Unit, with the following:
 1. Piping, valves, and unions. Include thermometer if not in cabinet.
 2. Piping Component Finish: Polished chrome plate.

2.11 EYEWASH STATION

- A. General: Wall mounted eyewash station with two spray type heads to deliver water for rinsing eyes in compliance with ANSI Z358.1.
- B. Available Manufacturers:
 1. Guardian
 2. Haws

3. Approved equal.

C. Connections

1. 1/2-inch NPT female supply inlet
2. 1-1/4-inch NPT female outlet

D. Bowl: 11-1/2-inch diameter stainless steel bowl.

E. Mounting: Cast aluminum wall bracket with corrosion resistant powder coated finish.

2.12 ESCUTCHEONS

A. Escutcheons shall be chrome-plated cold rolled steel or stainless steel.

2.13 SLEEVE PENETRATION SYSTEMS

A. Available Manufacturers:

1. ProSet Systems, Inc.
2. Approved equal.

B. Description: UL 1479, through-penetration firestop assembly consisting of sleeve and stack fitting with firestopping plug.

C. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

D. Stack Fitting: ASTM A 48, gray-iron, hubless-pattern, wye-branch stack fitting with neoprene O-ring at base and gray-iron plug in thermal-release harness in branch. Include PVC protective cap for plug.

2.14 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, metal-bellows type with pressurized metal cushioning chamber. Sizes indicated are based on ASSE 1010 or PDI-WH 201, Sizes A through F.

B. Available Manufacturers:

1. Josam Co.
2. Smith, Jay R. Mfg. Co.
3. Tyler Pipe; Wade Div.
4. Zurn Industries, Inc.
5. Approved equal.

C. Downspout Boots: ASTM A 48, gray-iron casting, with NPS 3 outlet; shop-applied bituminous coating; and inlet size to match downspout.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install specialties in accordance with manufacturers' installation instructions and recommendations.
- B. Install indicating devices so they may be easily read from floor level and are readily accessible for maintenance and service.
- C. Strainers
 - 1. Provide strainers with capped blow down valves.

END OF SECTION 15430

SECTION 15515 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work consists of all labor, materials, equipment, and incidentals necessary to complete the hydronic heating system.
- B. Equipment and appurtenances include compression tanks, air vents, air separators, strainers, flow indicators, flow controls, flow meters, and relief valves.
- C. Related Sections
 - 1. Section 01810 – Testing, Commissioning and Training
 - 2. Section 15050 – Basic Mechanical Requirements
 - 3. Section 15110 – Valves
 - 4. Section 15140 – Pipe and Fittings

1.2 REFERENCES

- A. This Section incorporates by reference the latest revisions of ASTM, ASME and the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and the listed documents, the requirements of this Section shall prevail.

1.3 REGULATORY REQUIREMENTS

- A. Conform to ASME Boilers and Pressure Vessels Code Section 8D for manufacture of tanks.

1.4 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.5 SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Submit product data for manufactured products and assemblies required for this project.
- C. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- D. Submit manufacturer's installation instructions under provisions of Section 01300.

1.6 OPERATION AND MAINTENANCE DATA

- A. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original packing.
- B. Store and protect products to prevent damage and exposure to deteriorating elements.

1.8 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During the commissioning, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.

PART 2 - PRODUCTS

2.1 BLADDER TYPE EXPANSION TANKS (T-3, 4)

- A. Construction: Welded steel, tested and stamped in accordance with Section 8D of ASME Code; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
- B. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psig.
- C. Size: See schedule on drawings.
- D. Available Manufacturers:
 - 1. Taco
 - 2. Approved equal.

2.2 AIR VENTS

- A. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.
- B. Float Type: Brass or semi-steel body, copper float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- C. Available Manufacturers:
 - 1. Bell and Gossett
 - 2. Approved equal.

2.3 AIR SEPARATORS

- A. Dip Tube Fitting: For 125 psig operating pressure; to prevent free air collected in boiler from rising into system.
- B. Air Elimination Valve: Bronze, float operated, for 125 psig operating pressure.
- C. Combination Air Separators/Strainers: Steel, tested and stamped in accordance with Section 8D of ASME Code, for 125 psig operating pressure, with galvanized steel integral strainer with 3/16 inch (5 mm) perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.
- D. Available Manufacturers:
 - 1. Bell and Gossett,
 - 2. Approved equal.

2.4 STRAINERS

- A. Size 2 inch (50 mm) and under: Screwed brass or iron body for 175 psig working pressure, Y pattern with 20 mesh stainless steel screen.
- B. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged iron body for 175 psig working pressure, Y pattern with 20 mesh stainless steel screen.
- C. Available Manufacturers:
 - 1. Sarco
 - 2. Approved equal.
- D. For all strainers (except FTU coil strainers), provide hose bibb as blow-down valve.

2.5 FLOW INDICATORS

- A. Brass construction, threaded for insertion into piping system, packless, with paddle with removable segments, vapor proof electrical compartment with switches.

2.6 FLOW CONTROLS

- A. Construction: Brass or bronze body with double union for easy removal, temperature and pressure test plug on inlet.
- B. Calibration: Control flow within 5 percent of selected rating, over pressure absorption range of 1 to 14 psi.
- C. Control Mechanism: Stainless steel piston or regulator cup, operating against stainless steel helical or wave formed spring.
- D. Accessories: In-line strainer on inlet and ball valve on outlet.

E. Available Manufacturers:

1. Griswold Control
2. Approved equal.

2.7 FLOW METERS

- A. Calibrated, stainless steel annular primary flow element with precision machined ports, nameplate and safety shut off valves and quick coupling connectors.
- B. Station shall be weld insert type or nipple section.
- C. Portable meter consisting of case containing one, 2.3 percent accuracy manometer. Color coded 12 feet long hoses for static and dynamic pressure connections, with master chart for direct reading to gpm. Contractor shall turn the meter over to the Architect at the end of the project for use by City and Borough of Juneau maintenance personnel.
- D. Available Manufacturers:
 1. Ellison Annubar
 2. Approved equal.

2.8 FLOW CONTROL VALVES

- A. Construction: Bronze body, with rubber diaphragm and contoured orifice plate to provide constant flow rate over the pressure differential range.
- B. Available Manufacturers:
 1. Hays Fluid Controls
 2. Approved equal.

2.9 RELIEF VALVES

- A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.
- B. Available Manufacturers:
 1. Watts
 2. Approved equal.

2.10 PRESSURE REDUCING FILL VALVE

- A. Description:
 1. Service: Make-up water to Boiler
 2. Type: Direct acting.

3. Body and Trim: Bronze
4. Diaphragm: EPT.
5. Connection Type: 1/2-inch NPT.
6. Brass inlet strainer and integral low inlet pressure check valve.
7. Pressure Reducing Valve
 - a. Set-screw adjustment between 10 and 25 psig.
 - b. Factory Set Point: 12 psig.
8. Pressure Relief Valve
 - a. Set-screw adjustment between 20 and 40 psig.
 - b. Factory Set Point: 20 psig.
9. Maximum Inlet Pressure: 125 psig.
10. Design Temperature: 225 degrees F.
11. Available Manufacturers:
 - a. Bell & Gossett, Model 8 Dual Unit
 - b. Approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. Install specialties in accordance with manufacturer's instructions to permit intended performance.
- B. Support tanks inside building from building structure. Seismically brace per code requirements.
- C. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- D. Provide air vents at system high points and as indicated with isolation valves.
- E. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- F. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- G. Provide valved drain and hose connection on strainer blow down connection.
- H. Provide relief valves on compression tank.
- I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- J. Pipe relief valve outlet to nearest floor drain.
- K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

135-3510019

END OF SECTION 15515

SECTION 15519 - ELECTRIC BOILER

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged, factory-fabricated and -assembled electric boiler, trim, and accessories for generating heating water.

1.2 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
 - a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 15 Section "Mechanical Vibration and Seismic Controls."
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and maintenance data.
- G. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

- C. NFPA Compliance: Design and fabricate boilers to comply with NFPA 70, "National Electrical Code," Article 424, Paragraphs G and H.
- D. UL Compliance: Test boilers for compliance with UL 834, "Heating, Water Supply, and Power Boilers--Electric." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace pressure vessels of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: provide a 3 year limited warranty on the vessel and a 1 year limited warranty on parts.

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. 01810: Testing, Commissioning and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Aerco
 - 2. Cleaver Brooks, Inc.
 - 3. Lochinvar Corporation
 - 4. Patterson-Kelley
 - 5. Approved equal.

2.2 MANUFACTURED UNITS

- A. Description: Factory-fabricated, -assembled, and -tested electric boilers with trim and controls necessary to generate hot water.

- B. Pressure Vessel: The boiler vessel shall be constructed in accordance with Section IV of the ASME Boiler and Pressure Vessel Code requirements, "H" stamped and registered with the National Board of Boiler and Pressure Vessels.
- C. Nozzles: The vessel shall be equipped with a threaded 3" inlet, a threaded 3" outlet, safety valve and drain nozzle connections as required.
- D. Insulation: Two layers of minimum 2-inch thick, glass-fiber insulation.
- E. Jacket: The vessel shall be enclosed in a rectangular 16-gauge jacket. The assembled electric boiler jacket shall have an acrylic enamel finish. Jacket shall have a full-length hinged access door with key lock for access to heating elements and controls.
- F. Heating Elements: The immersion heating elements shall be low watt density with an incoloy outer sheath. The heating elements shall be a three beam design and shall mount in individual tank flanges.
- G. Mounting base to secure 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 Division 15 Section "Mechanical Vibration and Seismic Controls" when mounting base is anchored to building structure.

2.3 TRIM

- A. Aquastat Controllers: Operating auto-reset high limit.
- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- D. Boiler Air Vent: Automatic.
- E. Dip-tube in water outlet.
- F. Drain Valve: Minimum NPS 3/4 hose-end ball valve sized per requirements of authorities having jurisdiction.

2.4 CONTROLS

- A. Refer to Section 15975 "Direct Digital Control System".
- 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.
7. Supply-voltage indicator.
8. Set-Point Adjust: Set points shall be adjustable.
9. 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.

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 pressure.
2. Low-Water Cutoff Switch: Electronic probe shall prevent boiler operation on low water. Cutoff switch shall be manual-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, common trouble alarm.
 - b. Control: On/off operation, hot water supply temperature set-point adjustment.

2.5 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 fused disconnect switch.
2. Interlock with access door to de-energize power with access door open.

B. Electrical Enclosures: NEMA 250, Type 1 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: 3-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 the wiring diagram.

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatic Test: Factory test assembled boiler including hydrostatic test.

2.7 PERFORMANCE

- A. Capacities and Characteristics: See Schedule on Drawings.

PART 3 - EXECUTION

3.1 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete materials and installation requirements are specified in Division 3.
- B. Install electrical devices furnished with boiler but not specified to be factory mounted.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.
- D. Install piping from safety relief valves to nearest floor drain.
- E. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- F. Ground equipment according to Division 16 Section "Grounding and Bonding."
- G. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15519

SECTION 15725 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNIT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Variable-air-volume, air-handling unit.

B. Related Sections

1. Section 01300 – Contractor Submittals
2. Section 01810 – Testing, Commissioning and Training
3. Section 15050 – Basic Mechanical Requirements
4. Section 15975 – Direct Digital Control (DDC) System

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design:** Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. Seismic Performance:** Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.3 SUBMITTALS

- A. Product Data:** For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

- B. Delegated-Design Submittal: For vibration isolation and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
- C. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Source quality-control reports.
- E. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification:
 - 1. Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
 - 2. Unit sound ratings will be reported in accordance with ARI 260 for inlet and discharge sound power levels.
 - 3. Unit will conform to ARI 410 for capacities, pressure drops, and selection procedures of air coils.
- D. AMCA Certification:
 - 1. Unit will conform to AMCA 210 for fan performance ratings.
 - 2. Damper performance will comply with AMCA 500.
 - 3. Airflow Monitoring Stations will be rated in accordance with AMCA 611-95 and bear a Certified Ratings Seal for Airflow Measurement Performance.
- E. E.T.L. Standards: Unit will conform to E.T.L. standards.

- F. Unit casing radiated sound ratings will be reported in accordance with ISO 9614 parts 1&2 and ANSI S12.12.
- G. Motors covered by the Federal Energy Policy Act (EPACT) will meet EPACT requirements.
- H. Air-handling units will be ISO9001 certified.
- I. Comply with NFPA 70.

1.5 WARRANTY

- A. Warranty unit and factory packaged controls for eighteen (18) months from date of shipment or twelve (12) months from date of start-up – whichever comes first. Warranty will be limited to manufacturer's defects on parts.

1.6 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. 01810: Testing, Commissioning and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 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. Buffalo Air Handling.
 - 2. Carrier Corporation; a member of the United Technologies Corporation Family.
 - 3. McQuay International
 - 4. Scott Springfield Mfg. Inc.
 - 5. Trane; American Standard Inc.
 - 6. YORK International Corporation.
 - 7. Approved equal.

2.2 UNIT CASINGS

- A. Casing leakage shall not exceed 1% of design CFM at $\pm 8''$ static pressure differential across casing.

- B. Panel deflection shall not exceed $L/240$ at $\pm 8''$ static pressure differential across casing.
- C. Unit casing shall consist of a structural frame and insulated roof, wall, and floor panels.
- D. Removal of wall panels shall not affect structural integrity of units.
- E. Unit shall have double wall, 2" insulated panels for walls, roof, and floor. Exterior skin will be galvanized sheet steel. Individual segments will have perforated galvanized interior liner.
 - 1. Panels with perforated liner will have 1" of 3 lb./ft.³ fiberglass board insulation, faced to prevent fiber erosion, and 1" of foam insulation. Exterior skin will be galvanized sheet steel. Interior liner will be perforated galvanized. Minimum perforated panel thermal resistance will be $R10 \text{ hr-ft}^2\text{-}^\circ\text{F/BTU}$.
- F. Floor panels shall be double wall construction, designed to provide at most $L/240$ deflection when subjected to a 300 lb. load at mid-span.
- G. Unit casing shall be insulated with spray injected foam to achieve a minimum thermal resistance of $R12 \text{ hr-ft}^2\text{-}^\circ\text{F/BTU}$.
 - 1. Insulation application meets the requirements of NFPA 90A.
 - 2. Drain pans will be insulated with spray injected foam.
- H. Double wall access doors shall be provided on sections as shown on product drawings.
 - 1. Stainless steel hinges permit a 180° door swing.
 - 2. Access door shall be of the same material type as exterior/interior casing.
 - 3. Access door latches shall use a roller cam latching mechanism.
- I. View ports shall be double-pane tempered glass.
- J. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
 - 1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 15071 "Mechanical Vibration and Seismic Controls" when air-handling unit frame is anchored to building structure.

2.3 FAN, DRIVE, AND MOTOR SECTION

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
 - 1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.

- b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- B. 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; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- C. Bearings and Drives:
 - 1. Fan bearings shall have average life (L50) of at least 200,000 hours. Bearing fatigue life ratings will comply with ANSI/AFBMA 9.
 - 2. Forward curved fans smaller than 18" will have permanently lubricated bearings. Re-greaseable fan bearings will be factory lubricated and equipped with standard hydraulic grease fittings.
 - a. Drives on fans with VFDs shall be fixed pitch.
- D. Motor:
 - 1. Fan motors shall be built in accordance with the latest NEMA and IEEE standards.
 - 2. Fan motors shall comply with ASHRAE Standard 90.1.
 - 3. Fan motors shall be furnished in sizes, electrical power and starting characteristics as shown in performance specifications.
 - a. Fan motors shall be rated for continuous, full load duty at 104°F (40°C) ambient temperature and 1.15 service factor.
 - b. Fan motors shall be NEMA design ball bearing type.
 - c. Fan motors shall meet, at a minimum, NEMA high efficiency standards.
 - d. Motors shall be inverter rated suitable for use with variable frequency drives, per NEMA MG-1 Part 30.

2.4 HEAT RECOVERY WHEEL SECTION

- A. The Heat Recovery Wheel shall be factory installed as an integral part of the air-handling unit utilizing the same casing specification herein. The Heat Recovery Wheel shall be integrated in the overall unit design to maximize the performance of downstream components. The factory installed heat recovery wheel shall incorporate a rotary enthalpy wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
- B. The entire heat recovery wheel assembly shall have a 5 year parts warranty, from date of shipment.
- C. Heat Recovery Wheel Performance and Certification
 - 1. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84-1991, Method of Testing Air-to-Air Heat Exchangers and ARI Standard 1060-2000, Rating Air-to-Air Energy Recovery Ventilation Equipment.
 - 2. Heat recovery wheel shall bear the ARI 1060 Certification Seal. Heat recovery wheel that do not bear the ARI 1060 Certification Seal shall not be acceptable.

3. Heat recovery wheel shall be listed in the ARI Certified Products Directory (online at www.ariprimenet.org, reference “product types”, then “air-to-air energy recovery ventilators (ERV)”, then “component”).
 4. Heat recovery wheel shall be an Underwriters Laboratories Recognized component for electrical and fire safety.
- D. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box.
- E. Section Casing
1. The heat recovery wheel section shall be of solid double-wall construction. All exterior and interior panels shall be made of galvanized steel.
 2. The casing shall be able to withstand + or – 8” of static pressure with a maximum air leakage of 1% of total CFM.
 3. The casing shall be insulated with a minimum of R-13 insulation.
- F. Heat Recovery Wheel Construction
1. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel.
 2. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours, permanently sealed.
 3. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
 4. The wheel shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. These layers shall be effectively captured in the stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
- G. Heat Recovery Wheel Desiccant
1. The heat recovery wheel shall have a solid, non-migrating desiccant that is permanently bonded without the use of binders or adhesives.
 2. The desiccant shall be silica gel for moisture handling capacity in the working range above 30% relative humidity. Molecular sieve desiccants shall not be acceptable.
 3. The substrate shall be lightweight polymer and shall not degrade nor require coatings for application in high-humidity, coastal, or marine environments.
 4. Wheel segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- H. Removable Wheel Segments
1. Wheel shall be provided with removable individual pie-shaped wheel segments that are inset into the self-supporting wheel structure. These individual segments shall be removable without the use of tools to facilitate maintenance and cleaning.
- I. Access

1. Access doors shall be provided to allow for the removal of wheel segments. Adequate space and access shall be provided for motor, bearing, and belt removal.

J. Wheel Motor

1. The wheel drive motor shall be provided, mounted in the cassette frame and supplied with a connector for field service. The wheel drive motor shall be thermally protected and UL Component Recognized. The wheel drive shall be no greater than 0.5 hp.

K. Seals and Belts.

1. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.

2.5 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with ARI 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. Coils shall not act as structural component of unit.
4. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Section 15071 "Mechanical Vibration and Seismic Controls" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.

B. Electrical Heating Coil, Controls, and Accessories: Comply with UL 1995.

1. Casing Assembly: 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. Over-temperature 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. Electric Heating Coils shall be equipped with SCR Controls.
6. Control Panel: Unit mounted with disconnecting means and over-current protection.
 - a. Magnetic 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.

2.6 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a Minimum Efficiency Reporting Value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for angular orientation, with access doors as shown in the drawings. Filters shall be removable from one side or lifted out from access plenum.

B. Disposable Panel Filters:

1. Factory-fabricated, viscous-coated, flat-panel type.
2. Thickness: 2 inches.
3. Merv (ASHRAE 52.2): 7.
4. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
5. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

2.7 DAMPERS

- A. General Requirements for Dampers: Dampers will have a maximum leakage rate of 4 CFM/square foot at 1-inch w.g. and comply with ASHRAE 90.1.
- B. Damper Operators: Comply with requirements in Section 15975 "Direct Digital Control System."
- C. Face-and-Bypass Dampers: Opposed-blade, galvanized-steel dampers with cadmium-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame and with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
- D. Outdoor- and Return-Air Mixing Dampers: Parallel-blade, galvanized-steel dampers mechanically fastened to cadmium-plated steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
- E. Maximum damper torque requirement will be 7 in.-lbs/ft.²
- F. Dampers shall have airfoil blades with extruded vinyl edge seals and flexible metal compressible jamb seals.

2.8 DIFFUSERS

- A. Perforated steel diffuser plates shall be installed between fans and downstream components when required to ensure proper velocity profiles across downstream components.

2.9 APPURTENANCES

- A. Base rails suitable for rigging and lifting shall be provided.
- B. Lifting lugs shall be provided where required for proper lifting.

2.10 FINISHES

- A. External unit surfaces shall be factory cleaned prior to finishing.
- B. Unit shall be painted.
 - 1. Painted units shall be prime-coated prior to painting.
 - 2. Paint shall be acrylic polyurethane.
 - 3. Painted unit shall exceed 500-hour salt spray test, with (5%) solution, without any sign of red rust when tested in accordance with ASTM B-117.

2.11 PERFORMANCE

- A. Capacities and Characteristics: See Schedule on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment Mounting: Install air-handling unit using elastomeric pads. Comply with requirements for vibration isolation devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- E. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 15 Section "Duct Accessories."

END OF SECTION 15725

SECTION 15764 - CONVECTION HEATING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hydronic Electric baseboard radiators.
- B. Related Sections
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 01810 – Testing, Commissioning, and Training
 - 3. Section 15050 – Basic Mechanical Requirements
 - 4. Section 15975 – Direct Digital Control (DDC) System

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.

1. 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Berko Electric Heating; a division of Marley Engineered Products.
 2. Indeeco.
 3. Markel Products; a division of Marley Engineered Products.
 4. Qmark Electric Heating; a division of Marley Engineered Products.
 5. Approved equal.
- B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.
- C. Heating Elements: Elements shall be high quality nickel chromium wire encased in magnesium oxide and sealed in copper tube. The heating element shall be sealed in 0.312" diameter copper tube and be immersed in heat transfer liquid. Aluminum fins shall be mechanically bonded to the entire heated length of the element.
- D. Automatic Linear Limit: Linear automatic thermal limit shall transverse entire heater length of element and protect heater in case of an over-temperature condition.
- E. Enclosures: Heat casing shall be constructed of 6063 extruded aluminum, minimum thickness 12 gauge. Outlet grill shall cover entire length of air discharge opening and be constructed of steel. Casing and grill shall be powder coated.
- F. Unit Controls: Remote line-voltage thermostat.
- G. Accessories:
 1. Filler sections without a heating element matching the adjacent enclosure.
 2. Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.
- H. Performance: See schedule on drawings.

PART 3 - EXECUTION

3.1 BASEBOARD RADIATOR INSTALLATION

- A. Install units level and plumb.
- B. Install baseboard radiators according to Guide 2000 - Residential Hydronic Heating.
- C. Install enclosure continuously around corners, using outside and inside corner fittings.

- D. Join sections with splice plates and filler pieces to provide continuous enclosure.
- E. Install access doors for access to valves.
- F. Install enclosure continuously from wall to wall.
- G. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

3.2 CONNECTIONS

- A. Ground electric convection heating units according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper convection heating unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION 15764

SECTION 15772 - RADIANT HEATING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Contractor designed radiant heating system, including pipes, fittings, and piping specialties.
- B. Related Sections
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 01810 – Testing, Commissioning, and Training.
 - 3. Section 15050 – Basic Mechanical Requirements

1.2 SUBMITTALS

- A. Product Data: For each type of radiant heating pipe, fitting, manifold, specialty, and control.
- B. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.
- C. Operation and maintenance data.

1.3 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section: 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 PEX PIPE AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. REHAU.
 - 2. Stadler-Viega.
 - 3. Approved equal.

- B. Pipe Material: PEX plastic according to ASTM F 876.
- C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- D. Fittings: ASTM F 1807, metal insert and copper crimp rings.
- E. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

2.2 DISTRIBUTION MANIFOLDS

- A. Manifold: Minimum NPS 1, 304 stainless steel.
- B. Mixing Station
 - 1. Body: Brass and copper.
 - 2. Pump: Factory attached and tested Grundfos UPS40-160/2 pump. See Division 15 Section "Hydronic Pumps".
 - 3. Valves: 1-inch diverting valve made to accept actuator, two 1-inch ball valves.
 - 4. Threaded end connections
 - 5. Two 6-5/8-inch wall mounting brackets.
- C. Main Shutoff Valves:
 - 1. Factory installed on supply and return connections.
 - 2. Two-piece body.
 - 3. Body: Brass or bronze.
 - 4. Ball: Chrome-plated bronze.
 - 5. Seals: PTFE.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 225 deg F.
- D. Manual Air Vents:
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Key furnished with valve, or screwdriver bit.
 - 4. Inlet Connection: NPS 1/2.
 - 5. Discharge Connection: NPS 1/8.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 225 deg F.
- E. Balancing Valves:
 - 1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
 - 2. Ball or Plug: Brass or stainless steel.
 - 3. Globe Cartridge and Washer: Brass with EPDM composition washer.
 - 4. Seat: PTFE.
 - 5. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.

6. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
7. CWP Rating: Minimum 125 psig.
8. Maximum Operating Temperature: 250 deg F.

F. Zone Control Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Actuator: Replaceable electric motor.
6. CWP Rating: Minimum 125 psig.
7. Maximum Operating Temperature: 250 deg F.

G. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

H. Mounting Brackets: Copper, or plastic or copper-clad steel, where in contact with manifold.

2.3 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb, minimum.
4. Temperature Range: Minus 40 to plus 185 deg F.

B. Floor-Mounting Staples:

1. Steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch.
3. Width: Minimum, wider than tubing.

C. Floor-Mounting Clamps:

1. Two bolt, steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch.

3. Width: Minimum, wider than tubing.

D. Floor-Mounting Tracks:

1. Aluminum or plastic channel track with smooth finish, no sharp edges.
2. Minimum Thickness: 1/16 inch.
3. Slot Width: Snap fit to hold tubing.
4. Slot Spacing: 2-inch intervals.

E. Modular Interlocking Blocks:

1. Polypropylene snap-together blocks with grooves to support piping.
2. Galvanized sheet metal or aluminum emission plates.
3. Natural mineralboard cover panel.

2.4 CONTROLS

- A. Temperature-control devices and sequence of operations are specified in Division 15 Section "Direct Digital Controls".

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Install the following types of radiant heating piping for the applications described:
1. Piping in Interior Reinforced-Concrete Floors: PEX.
 2. Piping in Level Fill Concrete Floors (Not Reinforced): PEX.

3.2 INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general zoning of systems. Contractor to indicate piping locations and arrangements to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated in shop drawing submittal unless deviations to layout are approved on Shop or Coordination Drawings.
- B. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
- C. Connect radiant piping to manifold in a reverse-return arrangement.
- D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.
- E. Install manifolds in accessible locations, or install access panels to provide maintenance access as required.
- F. Refer to Section 15140 "Pipe and Fittings" for pipes and connections to hydronic systems and for glycol-solution fill requirements.

- G. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations/
- H. Piping in Interior Reinforced-Concrete Floors:
1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
 2. Space cable ties a maximum of 18 inches o.c., and at center of turns or bends.
 3. Maintain 2-inch minimum cover.
 4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
 5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.
- I. Piping in Level Fill Concrete Floors (Not Reinforced):
1. Secure piping in concrete floors by attaching pipes to subfloor using tracks, clamps, or staples.
 2. Space tracks, clamps, or staples a maximum of 18 inches o.c., and at center of turns or bends.
 3. Maintain 3/4-inch minimum cover.
 4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
 5. Maintain minimum 40-psig pressure in piping during the concrete pour and continue for 24 hours during curing.
- J. Revise locations and elevations as required to suit field conditions and ensure integrity of piping and as approved by Architect.
- K. After system balancing has been completed, mark balancing valves to permanently indicate final position.
- L. Perform the following adjustments before operating the system:
1. Open valves to fully open position.
 2. Check operation of zone control valves.
 3. Set temperature controls so all zones call for full flow.
 4. Purge air from piping.
- M. After the concrete has cured, operate radiant heating system as follows:
1. Start system heating at a maximum of 10 deg F above the ambient radiant panel temperature, and increase 10 deg F each following day until design temperature is achieved.
 2. For freeze protection, operate at a maximum of 60 deg F supply-water temperature.

3.3 FIELD QUALITY CONTROL

- A. Prepare radiant heating piping for testing as follows:
 - 1. Open all isolation valves and close bypass valves.
 - 2. Open and verify operation of zone control valves.
 - 3. Flush with clean water, and clean strainers.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning radiant heating piping components that do not pass tests, and retest as specified above.
- D. Prepare a written report of testing.

END OF SECTION 15772

SECTION 15810 – SHEET METAL DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies sheet metal ductwork, including all labor and materials necessary to complete the HVAC system and special exhaust systems. Ductwork shall be designed and custom fabricated specifically for the applications shown.
- B. Related Sections
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 15050 – Basic Mechanical Requirements
 - 3. Section 15082 – Duct Insulation
 - 4. Section 15820 – Ductwork Accessories
 - 5. Section 15950 – Heating, Ventilation, and Air Conditioning Systems Testing, Adjusting and Balancing.

1.2 REFERENCES

- A. This Section incorporates by reference the latest revisions of ASTM, ANSI and the following documents. They are a part of this Section as specified and modified. In case of a conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ASHRAE Handbook	Fundamentals, Duct Design
ASHRAE Handbook	HVAC Systems and Equipment Duct Construction
SMACNA	Low-Pressure Duct Construction Standards
SMACNA	Industrial Duct Construction Standards - Round
NFPA	Standard 90A - Installation of Air Conditioning and Ventilating Systems
IMC	International Mechanical Code
IBC	International Building Code
NADCA	National Air Duct Cleaners Association

1.3 SYSTEM DESCRIPTION

- A. Design criteria and requirements:
 - 1. Low pressure ductwork: Ventilation and air conditioning ductwork for supply, return and exhaust ducts shall be in accordance with the latest revision of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Duct Construction Standards.

1.4 SUBMITTALS

- A. Submit shop drawings of ductwork layout at 1/4 inch to 1 foot scale and product data under provisions of Section 01300.
- B. Submit shop drawings of seismic bracing of ductwork in accordance with latest SMACNA standard.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver fabricated duct sections and fittings in containers or fitted with temporary braces to prevent damage.

PART 2 - PRODUCTS

2.1 LOW PRESSURE DUCTWORK

- A. Materials
 - 1. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.
 - 2. Steel Ducts: ASTM A 653 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 ounce per square foot for each side in conformance with ASTM A 90.
 - 3. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.
 - 4. Fasteners: Rivets, bolts, or sheet metal screws.
 - 5. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy adhesive. Durkee-Atwood, Permatite Class I or Hardcast 601.
 - 6. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
 - 7. Hanger Strap: Galvanized steel strap only in concealed spaces.
- B. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures of up to 2 inches water gage positive pressure, 2 inches water gage negative pressure and 2,500 feet per minute maximum velocity.
- C. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.
- D. Construct TEEs, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide air foil turning vanes.

- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- F. Provide easements where ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.
- G. Connect flexible ducts to metal ducts with draw bands.
- H. Use double nuts and lock washers on threaded rod supports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Ducts shall be supported from 1-5/8-inch Unistrut channels bolted directly to concrete walls, wall studs, roof joists, or roof trusses. All metal shall be copper or electro-galvanized finish. Support duct in accordance with Manufacturer's Standardization Society (MSS) SP-69 and SP-58. Duct shall be braced for earthquake resistance as required by the IBC. A plastic coating shall be provided on hanger for dissimilar materials.
- B. Route ducts tight to structural elements.
- C. Route duct at maximum height. Where acoustical tiles are in the space where the new duct is routed, remove acoustical tile and replace as shown and specified. Where branch fire sprinkler pipes are supported from the roof deck with rods in the space where the new duct is routed, provide new supports as required for the fire sprinkler piping.
- D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. The inside of ducts visible through grilles and registers shall be painted black.
- G. Connect diffusers to ducts with 5 feet maximum length of flexible duct. Hold in place with strap or clamp.
- H. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- I. Unless otherwise noted, all ductwork operating between 1/2-inch and 2-inch of static pressure shall have transverse joints sealed.

3.2 ADJUSTING AND CLEANING NEW WORK

- A. Clean new duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

END OF SECTION 15810

SECTION 15820 – DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes sheet metal ductwork accessories for low pressure ductwork, including all labor and materials necessary to complete the duct systems.
- B. Related Sections:
 - 1. Section 01300 – Contractor Submittals.
 - 2. Section 15810 – Sheet Metal Ductwork.
 - 3. Section 15950 – Heating, Ventilation and Air Conditioning Systems Testing, Adjusting and Balancing.

1.2 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest editions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ASHRAE Handbook	Fundamentals, Duct Design
ASHRAE Handbook	HVAC Systems and Equipment, Duct Construction
SMACNA	Low-Pressure Duct Construction Standards
SMACNA	Industrial Duct Construction Standards - Round
NFPA	Standard 90A - Installation of Air Conditioning and Ventilating Systems
IBC	International Building Code with City of Seattle Amendments
IMC	International Mechanical Code with City of Seattle Amendments
NADCA	National Air Duct Cleaners Association

1.3 SYSTEM DESCRIPTION

- A. Design criteria and requirements:
 - 1. Ventilation and air conditioning ductwork for supply, return and exhaust ducts shall be in accordance with the latest revision of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Duct Construction Standards.

1.4 SUBMITTALS

- A. Product data for duct fittings, access doors, fire dampers, fire/smoke dampers, motorized dampers, including but not limited to dimensions, material, compliance to applicable standards and maintenance data under provisions of Section 01300.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver fabricated duct sections and fittings in containers or fitted with temporary braces to prevent damage.

1.6 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems function properly.
- B. See the following Division 1 & 15 Sections for all commissioning requirements related to the work of this Section.
 - 1. 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.
- B. Steel Ducts: ASTM A 653 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 ounce per square foot for each side in conformance with ASTM A 90.
- C. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.
- D. Fasteners: Rivets, bolts, or sheet metal screws.
- E. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy adhesive. Durkee-Atwood, Permatite Class I, Hardcast 601, or approved equal.
- F. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 ACCESS DOORS

- A. Provide where shown on Drawings **and** at locations not specifically shown but are required to facilitate maintenance or required by authorities having jurisdiction
- B. Doors shall close with air pressure, with latches and hinges. Provide gasket seal.
- C. Hardware: Ventlock 220 door handles, Ventlock 140 hinges.

- D. As manufactured by United McGill or approved equal.

2.3 VOLUME DAMPERS

- A. Low pressure ductwork
 - 1. Provide volume dampers at locations shown AND, even if not shown, at branches as needed for balancing.
 - 2. Volume dampers shall be designed and manufactured in accordance with SMACNA Duct Construction Standards.
 - 3. Volume dampers shall have locking quadrants.

2.4 FIRE AND FIRE/SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- B. Fabricate curtain type dampers of galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for low pressure ducts up to 12 inches in height.
- C. Fabricate multiple blade fire dampers with 16 gauge galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- D. Fusible links, UL 33, shall separate at 160 degrees F.
- E. Interconnect fire/smoke dampers with smoke detectors. Coordinate with existing fire alarm system.

2.5 BACKDRAFT DAMPERS

- A. Backdraft dampers shall be designed and fabricated to comply with design criteria and requirements for each application.
- B. Gravity backdraft dampers, size 18 x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturers' standard construction.
- C. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of 16 gauge galvanized steel, or extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.6 AIR TURNING DEVICES

- A. Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.

2.7 FLEXIBLE DUCT CONNECTIONS

A. Low pressure ductwork

1. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
2. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz per sq yd approximately 6 inches wide, crimped into metal edging strip.

2.8 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps. Temporary plastic plugs are not allowed for final patch.
- B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.9 WALL CAPS

- A. Provide aluminum wall caps with matching duct size.
- B. Wall caps shall be equipped with gravity damper and insect screen with exception of dryer vent cap. Dryer vent cap shall not have insect screen.
- C. Seal wall openings per architectural requirements.
- D. Paint wall caps to match to adjacent wall siding color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.

- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire and smoke dampers according to UL listing.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 4. At each change in direction and at maximum 50-foot spacing.
 - 5. Upstream from turning vanes.
 - 6. Control devices requiring inspection.
 - 7. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes:
 - 1. Head and Hand Access: 18 by 10 inches.
 - 2. Head and Shoulders Access: 21 by 14 inches.
- J. Label access doors according to Section 15075 "Mechanical System Painting and Identification" to indicate the purpose of access door.
- K. Install flexible connectors to connect ducts to equipment.
- L. Connect terminal units to supply duct with maximum 6-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- M. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- N. Connect flexible ducts to metal ducts with adhesive and draw bands.
- O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 15820

SECTION 15840 – AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Fan-powered air terminal units.

B. Related Sections Include:

1. Section 01300 – Contractor Submittals.
2. Section 01810 – Testing, Commissioning and Training
3. Section 15050 – Basic Mechanical Requirements
4. Section 15060 – Hangers and Supports
5. Section 15071 – Mechanical Vibration and Seismic Controls
6. Section 15075 – Mechanical Systems Painting and Identification
7. Section 15140 – Pipe and Fittings
8. Section 15810 – Sheet Metal Ductwork
9. Section 15820 – Ductwork Accessories
10. Section 15975 – Direct Digital (DDC) Control System

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances and method of field assembly, components, and location and size of each field connection.

1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Section 01600, Product Requirements.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.4 COORDINATION

- A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 & 15 Sections for all commissioning requirements related to the work of this Section.

- 1. 01810: Testing, Commissioning and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 FAN-POWERED AIR TERMINAL UNITS (FTU)

- A. Manufacturers:
 - 1. Nailor Industries of Texas Inc.
 - 2. Titus.
 - 3. Trane.
 - 4. Approved equal.
- B. Basis of design is Titus model DTFS-F of the sizes, capacities, and ratings shown in the drawings.
- C. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud.

- D. Casing: 20 gauge galvanized steel.
1. Casing Lining: Dual density glass fiber insulation that complies with UL 181 and NFPA 90A.
 2. Air Inlets: Round duct collar for the primary and ventilation air connections. The ventilation inlet shall be integral to the unit casing.
 3. Air Outlet: Rectangular discharge suitable for flanged duct connection.
 4. Access: Casing shall have top and bottom access panels, which allows removal of fan and servicing of terminal without disturbing duct connections.
 5. The terminal shall have internal and external attenuators factory installed. The external attenuator shall be slid into the operation position and secured without the need for additional screws. Factory provided attenuators that require field installation are not acceptable.
- E. Volume Damper: Primary and ventilation air damper assemblies shall be heavy guage steel with shaft rotating in Delrin self-lubricating bearings. Shaft shall be clearly marked on end to indicate damper position.
- F. Fan Section: Fan shall be constructed of steel and have a forward curved, dynamically balanced wheel with direct drive motor.
1. Lining: 1-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.
 2. Motor: Motors shall be designed for synchronous rotation and comply with requirements in Section 15050.
 - a. Speed Control: Infinitely adjustable with electronic controls.
 - b. Motor shall be able to be mounted with shaft in horizontal or vertical orientation.
 - c. Fan assembly shall include a tuned spring steel suspension and isolation between motor and fan housing.
 - d. ECM variable speed dc brushless motor.
 3. Air Filter: 1-inch fiberglass throwaway.
 4. Filter Holder: swing type.
- G. Electric Heating Coil: Electric coil shall be supplied and installed on the terminal by the terminal manufacturer.
1. Coils shall be factory installed on the terminal.
 2. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3-1/2 inches apart, staggered for maximum thermal transfer and element life, and balanced to ensure equal output per step.
 3. The integral control panel shall be housed in a NEMA 1 enclosure, with hinged access door for access to all controls and safety devices.
 4. Electric coils shall contain a primary automatic reset thermal cutout, a secondary replaceable heat limiter per element, differential pressure airflow switch for proof of flow, and line terminal block.
 5. Coil shall include an integral door interlock type disconnect switch, which will not allow the access door to be opened while power is on.
- H. Digital Electronic Controls:

1. The terminals shall be equipped with pressure independent direct digital controls supplied and mounted by the terminal unit manufacturer to be commissioned in the field by the controls contractor.
2. Controls shall be compatible with pneumatic inlet velocity sensors supplied by the terminal manufacturer. The sensor shall be multi-point center averaging type, with a minimum of four measuring ports parallel to the take-off point from the sensor. Sensors with measuring ports in series are not acceptable. The sensor must provide a minimum differential pressure signal of 0.03wg. at an inlet velocity of 500 fpm.
3. Controls shall be factory set for unit size and the scheduled minimum and maximum flow rates. Controls shall be field addressed by the controls contractor. All pneumatic tubing shall be UL listed fire retardant (FR) type. Each terminal shall be equipped with labeling showing unit location, size, and scheduled cfm.
4. The terminal manufacturer shall provide a Class II 24 Vac transformer and disconnect switch. Actuator shall be direct connection shaft mount type without linkage. All controls shall be installed in approved NEMA1 sheet metal enclosure by terminal manufacturer.

2.3 SOURCE QUALITY CONTROL

- A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- B. Label ceiling T-bar where FTU/VAV is located in ceiling using engraved 3- by 1-inch plastic with FTU/VAV number.
- C. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 CONNECTIONS

- A. Connect ducts to air terminal units according to Section 15810, Sheet Metal Ductwork.
- B. Connect wiring according to Division 16 Section.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 15840

SECTION 15850 – DIFFUSERS, GRILLES, AND REGISTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes all diffusers, grilles and registers associated with the heating, ventilating and air conditioning systems.
- B. Related Sections Include:
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 01810 – Testing, Commissioning and Training
 - 3. Section 15050 – Basic Mechanical Requirements
 - 4. Section 15075 – Mechanical Painting and Identification.
 - 5. Section 15810 – Sheet Metal Ductwork
 - 6. Section 15820 – Ductwork Accessories
 - 7. Section 15950 – Heating, Ventilation and Air Conditioning Systems Testing, Adjusting and Balancing

1.2 SYSTEM DESCRIPTION

- A. General: Diffusers, grilles and registers shall be the size and capacity indicated on the Drawings.

1.3 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
SMACNA	Sheet Metal and Air Conditioning National Association
ASHRAE	Room Air Distribution Equipment

1.4 SUBMITTALS

- A. Provide the following in accordance with the provisions of Section 01300. Performance data shall be obtained by testing procedures in accordance with ANSI/ASHRAE Standard 70-1971.
 - 1. Manufacturer's product literature which shall include a complete description of the ceiling diffusers, grilles, registers and extractors, and accessories sufficient to demonstrate compliance with the Specifications. Submittal to include but not be limited to the following:
 - a. Make, model, and dimensions

- b. NC sound data
- c. Velocity data.
- d. Static pressure drop data.
- e. Throw at applicable pattern deflection
- f. Finishes

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. 01810: General Commissioning Requirements

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but not limited to, the manufacturers listed for each type of diffuser, grill and register.

2.2 SUPPLY DIFFUSER (SD)

- A. Construction: Steel with factory standard finish.
- B. Type: Ceiling diffuser with field repositionable fixed louver directional core modules for 1, 2, 3 or 4-way discharge. Each core module shall be easily removable to adjust the damper in the neck of the diffuser.
- C. Manufacturer: Titus Model as shown in schedule on drawings or approved equal with opposed blade damper.

2.3 SUPPLY REGISTER (SR)

- A. Construction: Steel with factory standard finish.
- B. Type: Double deflection of sizes and mounting types shown on Drawings. Deflection blades shall be adjustable on 3/4-inch centers parallel to the long dimension of the grille. Blades shall have friction pivots on both ends to allow individual blade adjustment without loosening or rattling. Plastic blade pivots are not acceptable. Border shall be 1-1/4-inch wide on all sides. Opposed blade damper shall be operable from face of grille.

- C. Manufacturer: Titus Model as shown in schedule on drawings or approved equal.

2.4 RETURN GRILLE (RG)

- A. Construction: Steel with factory standard finish.
- B. Type: Fixed deflection of sizes and mounting types shown on Drawings. Deflection blades shall be fixed at zero degrees angle on 3/4-inch centers parallel to the long dimension of the grille. Border shall be 1 1/4-inch on all sides. Opposed blade damper shall be operable from face of grille.
- C. Manufacturer: Titus Model as shown in schedule on drawings or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide a factory-applied finish. Color for diffusers installed in suspended ceilings shall match ceiling tile color. Provide each unit with a felt gasket or seal.
- B. Align, connect and install diffusers, grilles, registers and extractors in accordance with the manufacturer's recommendations and with SMACNA Standards. Set each unit flat against the finished room surface. Make airtight connections to ductwork.

3.2 TESTING AND BALANCING

- A. Testing, adjusting and balancing shall be as specified in Section 15950.

END OF SECTION 15850

SECTION 15950 – HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies the labor and services necessary to test, adjust, and balance under actual operating conditions air and hydronic systems design flow rates. Nothing herein shall be construed as relieving the Contractor of its overall responsibility of this portion of the work.
- B. Related Sections
 - 1. Section 01300 – Contractor Submittals
 - 2. Section 01810 – Testing, Commissioning and Training
 - 3. Section 15050 – Basic Mechanical Requirements
 - 4. Section 15975 – Direct Digital Controls

1.2 REFERENCES

- A. This Section incorporates by reference the latest revisions to the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
 - 1. NEBB - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems
 - 2. ASHRAE 70 - Standards--Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets

1.3 QUALITY ASSURANCE

- A. Testing Agency: The Contractor shall procure the services of an independent air and hydronic balancing and testing agency, belonging to the National Environmental Balancing Bureau (NEBB), to perform air and hydronic balancing, testing and adjustment of systems.
- B. Codes and Standards: The Contractor shall comply with applicable procedures and standards of the certification sponsoring association:
 - 1. "National Standards for Field Measurements and Instrumentation, Total Systems "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", NEBB
 - 2. "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets", ASHRAE

- C. Calibration and maintenance of instruments and accuracy of measurements shall comply with the requirements of the standards.

1.4 SPECIAL REQUIREMENTS

- A. Tests and adjustments shall include the complete testing and balancing of hydronic systems and heating and ventilating systems and necessary adjustments to the heating and ventilation equipment to accomplish the specified design flow rates.
- B. Should any apparatus, material or work fail to meet the specified requirements in these tests, the Contractor shall make the necessary corrections and retest the apparatus, material, or work at no additional cost to the owner.
- C. Refer to Section 01014 for schedule and special constraints. The Contractor shall coordinate and schedule the work to comply with the constraints.

1.5 BALANCING

- A. General: The Contractor shall review Drawings and Specifications prior to testing and balancing the air and hydronic systems. The Contractor shall submit a proposed approach and schedule for approval prior to the start of testing and balancing work. Characteristics to be tested and adjusted to conform to the values specified include the following:
 - 1. Total airflow rates delivered by fans, heating and ventilating units, and air-handling units.
 - 2. Flow rates at grilles, diffusers, supply and exhaust and return ducts.
 - 3. Distribution patterns at air outlets.
 - 4. Total water flow rates at each hydronic heating system, control valve, and pump.
 - 5. Capacity and temperature rise or drop across each heating system.
 - 6. Operation and modulation of each control valve.
- B. Airflow Rate Measurements:
 - 1. Airflow rates shall be obtained by adjustment of the fan speeds or dampers. Flow rates shall be measured with supply, return, and exhaust systems operating with filter bank resistance midway between the design values specified for clean and dirty filters, with auxiliary systems in operation, and with doors and windows closed.
 - 2. Flow rates at grilles, branch ductwork and air distribution patterns shall be tested in strict accordance with ASHRAE Standard-70.
- C. Water Flow Rate Measurement: Total water flow rates shall be measured at each heating loop, control valve, and pump. Water flow rates shall be obtained by adjustment of balancing cocks, valves, and fittings. Flow rates shall be measured with control valves 100 percent open. Pump capacities shall be determined by differential pressure measure. Temperature shall be measured across the heat transfer elements in the system.

1.6 SUBMITTALS

- A. The following information shall be provided in accordance with Section 01300:
1. Qualifications of proposed independent air and hydronic balancing and testing agency.
 2. Sample copy of the NEBB report forms.
 3. Proposed approach and schedule of testing and balancing work.
 4. A description of each air and hydronic system including equipment to be balanced.
 5. A copy of this Specification Section with addenda updates, and referenced sections with addenda updates, with each paragraph check marked to show Specification compliance or marked to show deviations.

1.7 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During the commissioning, coordinate with the Commissioning Agent and make all adjustments required to demonstrate systems are working properly.

PART 2 - PRODUCTS

2.1 BALANCING REPORT

- A. Report Data: The final certified balancing report shall include the following actual field-verified data:
1. Equipment data
 - a. Manufacturer and model, size, arrangement, class, location, and equipment number.
 - b. Motor horsepower, voltage, phase, and full load amperage.
 - c. Fan cfm, static pressure, rpm, and operating motor BHP.
 - d. Pump gpm, discharge pressure, suction pressure, pressure change across pump, total discharge head, gpm at major equipment and operating motor BHP.
 2. Duct size, supply or exhaust recorded cfm, velocity, pressure measurements, and location of measurements.
 3. Pipe size, recorded gpm, velocity, pressure measurements, balancing valve size and model, location of measurements.
 4. Terminal units
 - a. Manufacturer and model, supply or exhaust locations, and identification number.
 - b. Recorded and design cfm.
 - c. Recorded and design noise levels and velocities, where specified.

B. Report Requirements:

1. Each individual final reporting form must bear the signature of the person who recorded the data and that of the supervisor of the reporting organization.
2. One certified organization shall perform the testing and balancing services.
3. Instruments which were used shall be listed and identified including the last date each was calibrated.

C. Final Report: Final report shall be submitted prior to Contractor's request for final inspection. In addition to providing specified data and information on applicable reporting forms, report shall include the following:

1. A schedule for testing and balancing parts of the systems which must be delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor. Delayed work shall be completed as early as the proper conditions will allow, after consultation with the Architect/Engineer.
2. Due to delayed testing, reports shall be submitted after execution of those services.
3. A total balance report shall include the following components:
 - a. General Information and Summary;
 - b. Instrument Calibration;
 - c. Air Systems;
 - d. Hydronic Systems;
 - e. Temperature Control Systems;
 - f. Special Systems;
 - g. Sound and Vibration Systems;
 - h. Record drawings with specified and measured flow rates.

2.2 CERTIFICATE OF COMPLETION

- A. At completion of testing and balancing, Contractor shall submit a Certificate of Compliance stating that each apparatus, device, outlet, and system has been tested, adjusted, and balanced so that it is operating in conformance with manufacturer's recommendations and with the specified conditions.

2.3 PRODUCT DATA

- A. The following information shall be provided in accordance with Section 01300:
1. The balancing report specified in Paragraph 15950-2.1.
 2. Documentation to confirm compliance with codes and standards.
 3. NEBB certification.

PART 3 - EXECUTION

3.1 GENERAL

- A. The balancing agency shall conduct the above field tests in the presence of the Architect/Engineer.
- B. Following completion of testing and balancing the system shall be left in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, patching all holes made to perform balancing and restoring thermostats to specified settings.
- C. Provide preliminary Testing, Adjusting and Balancing report to Commissioning Agent.

3.2 PERFORMANCE OF WORK

A. Air Systems:

- 1. General: Testing, adjusting, and balancing shall be performed after the system installation is complete but prior to acceptance of the project.
- 2. Measurements: The Contractor shall perform the following:
 - a. Measure and adjust air supply and exhaust units to deliver at least 100 percent of the design air volume at 100 percent economizer cooling.
 - b. Measure static air pressure conditions on fans, including filter and coil pressure drops, and total pressure across the fan.
 - c. Adjust fan speeds and motor drives within drive limitations, for required air volume. Set a speed to provide air volume farthest distance from the fan without excess static pressure. Check draw-amps of fans on initial start-up. If running amps exceed nameplate, shut off motor immediately, notify Architect/Engineer, and make necessary drive changes as directed.
 - d. Evaluate building and room pressure conditions to determine adequate supply and return air conditions.
 - e. VAV air handling/exhaust systems should be tested in full economizer cooling and AHU dampers in the more restrictive operating condition or for exhaust system with all dampers open.
- 3. Airflow rates shall be measured with supply, return, and exhaust systems operating with filter bank resistance midway between design values specified for clean and dirty filters, with auxiliary systems in operation. The deflection pattern of supply outlets shall be adjusted to ensure uniform air distribution throughout the space served.
- 4. Airflow rates supplied, exhausted, or returned shall be within plus or minus 10 percent of the design values specified for HVAC system.
- 5. Final balanced positions of balancing dampers and speed controllers are to be permanently marked.
- 6. After balancing is complete, at least one balancing damper on each fan system shall be wide open. At least one balancing damper on the low pressure side of each air terminal unit shall also be wide open. These dampers shall be identified on the balancing report.

TAB agent shall coordinate with DDC system installer to establish and set maximum fan speeds.

B. Hydronic Systems:

1. General: Testing, adjusting, and balancing shall be performed after the system installation is complete and prior to acceptance of the project.
2. Measurements: The Contractor shall perform the following:
 - a. Measure and adjust pumps to deliver at least 100 percent of the design water flow. Check draw-amps of running pumps. If amperage draw is in excess of nameplate, shut off immediately and notify Architect/Engineer. Proceed as directed by the Architect/Engineer.
 - b. Measure and adjust water flow for design conditions, plus or minus 10 percent.
3. Measure and adjust total water flow rates at each control valve.
4. Final balanced positions of balancing valves and speed controllers are to be permanently marked.
5. After balancing is complete, at least one balancing valve on each pump system shall be wide open. These valves shall be identified on the balancing report. TAB agent shall coordinate with DDC system installer.

3.3 FINAL INSPECTION

- A. Following completion of testing and balancing, but prior to submitting the balancing report, the Contractor shall recheck, in the presence of the Architect/Engineer, random selections of data water and air quantities, air motion, and sound levels recorded in the report. Points and areas for recheck shall be as selected by the Architect/Engineer. Measurement and test procedures shall be as approved for work forming basis of the report.
- B. Selections for recheck shall not exceed 25 percent of the total tabulated in the report.
- C. In the event the report is rejected, systems shall be readjusted and tested, new data recorded, new reports submitted, and new inspection tests made.
- D. Following acceptance of the reports by the Architect/Engineer, the Contractor shall permanently mark damper positions, circuit balancing valves, and balancing valves so that they can be restored to their correct position if disturbed at any time. If a balancing device is provided with a memory stop, it shall be set and locked. Devices shall not be marked until after final inspection.

END OF SECTION 15950

SECTION 15975 – DIRECT DIGITAL CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification describes the primary products and performance of the direct digital control system. The sequence of operation, input/output point lists, and mechanical drawings detail the scope of work for this project. The direct digital control equipment for this project shall be comprised of Invensys (TAC) Network 8000 controllers and associated devices to seamlessly interface with the existing City and Borough of Juneau “Signal” graphical host system.
- B. All work shall be coordinated with the existing DDC equipment.
- C. All components of the building management and control system must meet applicable jurisdictional code requirements.
- D. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- E. Provide power, including 120-volt power, to all DDC monitoring and control elements requiring power including but not limited to all DDC and/or temperature control panels. 120-volt circuits shall be provided in accordance with the requirements of Division 16.
- F. The HVAC unit manufacturer shall provide all automatically controlled dampers for the air handling unit (AHU). Actuators for the AHU are to be furnished by the DDC System Manufacturer. AHU unit manufacturer shall install automatically controlled dampers at the factory including functional testing for each unit.
- G. All other automatically controlled dampers shall be sized and furnished by the DDC System Manufacturer. Dampers shall be installed by the sheet metal contractor.

1.2 QUALITY ASSURANCE

- A. The direct digital control system for this project shall be furnished and installed by the factory authorized Invensys (TAC) contractor in Alaska. The control contractor shall maintain offices in Anchorage, Juneau, and Fairbanks with repair parts and maintenance personnel to ensure prompt response to an emergency call during the warranty period. The contractor shall maintain a complete sales, engineering, installation, and service organization.
- B. The control contractor shall hold a license or certification to design and install control systems for that manufacturer.
- C. The direct digital control system shall be installed by trained, qualified personnel and commissioned by factory trained technicians.

1.3 SYSTEM DESCRIPTION

- A. The direct digital control system shall be comprised of Invensys (TAC) Network 8000 equipment, air quality monitoring system and integrated equipment control, and field devices. The DDC system shall provide control for all designated equipment described in the sequence of operation and point lists. The distributed DDC equipment shall be networked to the Global Control Module (GCM) located in the boiler room. A Network Interface Module (NIM) shall be provided to allow the DDC system to communicate with the existing Host computer using the owner provided network. A modem shall be provided to allow back-up monitoring and control for the DDC system if required.
- B. System shall consist of stand-alone DDC panels, sensors, air data routers, air quality sensor suites, vacuum pumps, structured cable, transformer solenoids, relays, switches, sensing devices, indicating devices, transducers, automatic valves, actuators, operating software, operator training, installation labor, warranty and all other necessary material and labor to provide a complete operable system.

1.4 ACCEPTABLE MANUFACTURERS

- A. Invensys (TAC) Network 8000. No substitutions.
- B. Air Quality Monitoring system (Aircuity) shall be integrated as part of the DDC System Manufacturer's system and controls. DDC System manufacturer shall be responsible for installation, testing, and proper function of the Air Quality monitoring system.

1.5 SUBMITTALS

- A. Prior to installing the DDC systems, submit the following for review and approval.
 - 1. Control valve and control damper schedules.
 - 2. Product data/specification sheets for control system components and field devices.
 - 3. Control system installation drawings showing the equipment controlled, the locations of field devices, field wiring, sequence of operation, and bill of materials.

1.6 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted for review and approved before the final inspection and Owner training.
- B. The operation and maintenance manuals shall include the following information:
 - 1. A building management system user's guide. The guide shall include the following: log on procedure; viewing system information; viewing and acknowledging alarms; changing a setpoint; printing a trend or report; overriding a point.
 - 2. Maintenance information for all control components requiring periodic maintenance
 - 3. Complete system "As-Built" control drawings
 - 4. Complete software "As-Built" diagrams

1.7 WARRANTY

- A. A warranty period of one year shall commence upon acceptance of the systems by the Contracting Agency or use of the control equipment by the Owner for its intended purpose. The warranty shall consist of providing parts and labor as required to repair or replace parts of the control system that prove to be faulty due to defective materials or improper installation practices. This warranty excludes normal routine maintenance.

1.8 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.

- 1. 01810: Testing, Commissioning and Training

PART 2 - PRODUCTS

2.1 FACILITY MANAGEMENT SYSTEM HOST STATION HARDWARE

- A. The existing host station hardware will be used for this project.

2.2 FACILITY MANAGEMENT SYSTEM HOST STATION SOFTWARE

- A. The existing "Signal" host software will be used for this project. Provide new graphical monitoring/control screens for all DDC controlled equipment in the facility per existing standards.

2.3 STAND-ALONE DIRECT DIGITAL CONTROLLERS

- A. Provide modular, direct digital controllers for equipment control as described in the sequence of operation. Application specific direct digital controllers may be used for fin tube radiation, variable air volume units, and other remote equipment as required. This includes Invensys (TAC) Microzone II, PEM-1, MNHP, and MNL VAV controllers.
- B. Control points monitored or controlled by a direct digital controller shall be individually addressable. A full history accumulation shall be possible for all control points.
- C. Provide each direct digital controller with a microcomputer controller, power supply, input/output modules and termination module.
- D. Direct digital controllers shall have commanded override capability through the building management system and through direct connection to an optional portable operator's terminal.

- E. Direct digital controllers shall be capable of full operation as either a completely independent unit or as part of the networked control system.
- F. Direct digital controllers shall resume full operation without operator intervention following a loss of power. Each controller shall retain its system memory in non-volatile memory.
- G. Provide direct digital controllers with a minimum of one service port for the connection of an optional, portable terminal. The service port shall be either a built-in RS-232 data terminal port or RJ-11 type jack that connects to the portable terminal.

2.4 VARIABLE AIR VOLUME DIGITAL CONTROLLER (VAVDC)

- A. Controls shall be microprocessor based Pressure Independent Variable Air Volume Digital Controllers. The VAVDC shall be based on a microprocessor working from software program memory that is physically located in the VAVDC controller. The VAV controller "intelligence" shall be resident within the same enclosure that translates sensor signals into digital information. The VAVDC shall consist of a microprocessor, power supply, actuator, differential pressure transducer, field terminations, field adjustments and operation/application system software in a single integrated package. Systems not providing a single integrated package shall provide documentation supporting the use of the individual components in the application. Documentation shall include life cycle information for the actuator, sensor and control accuracy verification for the combination of the products. All input/output signals shall be directly hardwired to the VAVDC controller. Troubleshooting of input/output signals shall be executed through the wall sensor or HHOT connected at the wall sensor location.
- B. All control sequences programmed in the VAV controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained. Power failures shall not cause the VAV controller memory to be lost. There shall be no need for batteries to be recharged or replaced. The VAVDC shall meet UL-916, FCC Class A, and CSA agency approvals.
- C. The VAVDC controller shall have a space temperature sensor with integral room setpoint adjustment. The sensor setpoint shall be capable of being shared by up to 31 VAVDC's, providing coordinated control of zones containing multiple VAVDC's. In cases where a single room sensor is to be shared by multiple controllers and the system cannot accommodate the functions; a wall sensor with multiple sensing elements and a ganged setpoint adjustment, under a single sensor, shall be employed. The room sensor shall contain a push-button for override of unoccupied conditions, up and down arrows to scroll through attributes, and enter key to make changes and a plug-in communications jack for connection of a hand held operator terminal (HHOT). Provide a space sensor only with no push-button or display in public areas or as directed.
- D. Factory mounting of VAVDC's should be coordinated with the terminal unit supplier if possible. Provide field mounting of the controllers if required. The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box. The Contractor shall supply a low voltage transformer of sufficient capacity to power the VAVDC plus all reheat valves and/or contactors and fan circuits associated with the VAV terminal and actuator assemblies.

2.5 BUILDING AUTOMATION SYSTEM (BAS) COMMUNICATIONS

- A. The distributed stand-alone DDC controller trunk communications shall consist of a multi-drop RS-485 bus architecture. The distributed DDC controllers shall provide communication transient protection.

2.6 SENSING AND CONTROL OUTPUT REQUIREMENTS

A. Sensing

1. All sensing inputs shall be provided via industry standard signals. Temperature, humidity, differential pressure signals, and other signal inputs shall be one of the following types:
 - a. 0-20 mA
 - b. 4-20 mA
 - c. 0-5 VDC
 - d. 0-12 VDC
 - e. 1000 ohm platinum
 - f. 1000 ohm Balco (2.2 ohms/ F)
 - g. 10 k ohm Thermistor (at 25 C/77 F)
2. Custom, definable input signals (accept sensor inputs from RTD devices, other than those of the manufacturer). All signal inputs shall be compatible with the controllers used and with the requirements for readout of variables in true, scaled engineering units as specified.

B. Control Outputs

1. The control panel shall internally provide test points for the circuits driving the equipment contactor, for the purpose of troubleshooting the 120 VAC or 240 VAC circuit to the contactor. All such relays shall be of modular construction that can be easily and quickly replaced on an individual basis if the module were to be damaged.
2. Modulating outputs shall be industry standard 0-5 VDC, or 0-12 VDC with output spans to adapt to industry available control products. Milliamp outputs of 0-20 mA or 4-20 mA are also acceptable. Drive open/Drive closed type modulating outputs are acceptable for selected terminal unit control.

2.7 SENSORS

A. General:

1. Provide sensors with specified output type for remote sensing of temperature, humidity, pressure, air quality, and flow rate.
2. Provide two wire temperature and humidity sensors.

B. Space Temperature:

1. Thermistor or RTD with minimum 32-150F range, accuracy of +/-0.4 F over full range, and maximum drift of 0.1F/year. Provide adjustable sensors with temperature indication

in all areas except public areas or other areas as directed. Provide stainless steel plate type temperature sensors in all areas where the sensor may be subject to damage.

C. Duct Air Temperature, Probe Type:

1. Thermistor or RTD with minimum 32-150 F range, accuracy of +/-0.4 F over full range, and maximum drift of 0.1F/year. Mamac or equal.

D. Duct Air Temperature, Averaging Type:

1. RTD continuous sensing element with appropriate range, accuracy of +/- 0.75 F over full range, and maximum drift of 0.1 F/year. Mamac or equal.

E. Fluid Temperature:

1. Thermistor or RTD with minimum 30-230 F range, accuracy of +/-1.0 F over full range, and maximum drift of 1F per year. Mamac or equal. Provide appropriate thermal well for the pressure application to allow removal of the sensing element without draining the system.

F. Outside Air Temperature:

1. Platinum RTD with minimum -58-110 F range, Accuracy of +/-1.0 F over full range, and maximum drift of 1F per year. Mamac or equal. Provide sunshield and weatherproof box as required.

G. Fluid Pressure:

1. Semi-conductor strain gauge pressure transducer with range 150% of operating pressure and over pressure tolerance of 200% of range pressure, +/-2% accuracy over full range, and maximum drift of 1% full range per year. Kele PTX1E, Mamac or equal.
2. Provide with brass or stainless steel snubber and pigtail on steam applications.
3. Coordinate tap requirements with the mechanical contractor. Provide with gate or ball valve isolation.

H. Duct Static, Building Static, or Air Differential Pressure:

1. Semi-conductor strain gauge pressure transducer with range 150% of operating pressure and over pressure tolerance of 200% of range pressure, +/-2% accuracy over full range, and maximum drift of 1% full range per year. Mamac or equal.
2. Provide static pressure tips with integral compression fittings for reference tubing at duct penetrations.

I. Occupancy Sensor:

1. Passive infrared type (PIR)
2. Wall or corner mounting
3. Integral SPST isolated relay for BAS interface
4. Adjustable sensitivity and time delay
5. Fresnel lens with LED indicator
6. UL listed

7. WattStopper, Square D, or equal

J. Sensor Suite

1. The Sensor Suite shall be a distributed, network based, multipoint sensing device. The Sensor Suite shall be furnished as a complete, self contained unit, housing all electronics, sensing card cage, sampling manifolds, flow regulators, pressure regulators, firmware, and software.
2. The Sensor Suite shall provide communications between the Air Data Router sub network and the Server over an isolated RS-485 network. The Sensor Suite shall support communications with a sub network of 30 Air Data Routers; 30 other Sensor Suites, and an Information Management Server.
3. The Sensor Suite base unit shall consist of an enclosure; hinged door with latch; terminations area for both field wiring and Structured Cable connections; a communications/processor board; electronic flow measurement and controller assembly; and sensor bay.
4. The Sensor Suite shall utilize a card cage to allow for the ease of selection and installation of a diverse array of environmental and specialty sensors. As a minimum, the Sensor Suite shall incorporate the following Sensor Application Groups to meet the required applications:

Sensor Application Group			
	Particulates	Total Volatile Organic Compounds (VOC's)	Carbon Monoxide
Element-	Laser scatter sensor	Photo ionization Detector	Electrochemical sensor
Range-	PM2.5 .3 – 2.5µm particles	0-20+ ppm (as Isobutylene)	0-150 PPM
Accuracy-	± 25% of reading	± 2.5% of reading from 10x the detection level to full scale as Isobutylene	± 5% of reading
Resolution-	± 10% of reading	0.01 PPM	1 PPM
Response-	30 seconds	40 seconds	60 seconds

5. The Sensor Suite shall be modular in nature, and allow for the addition and removal of the sensors for application specific sensing requirements, and ease of calibration and service. Additional, modular sensor bay expansion capabilities shall be provided for additional sensors.
6. The Sensor Suite shall house an on-board flow regulator, orifice plate, and differential pressure sensor to maintain a continuous, regulated flow rate through the Structured Cable.
7. On-board diagnostics shall continuously perform system checks to insure the integrity of the Structured Cable against leaks, ruptures, splices, occlusions.
8. Each Sensor Suite shall contain a serial port for the interface with a portable computer. Sensor Suite and network interrogation shall be possible through this port.
9. Sensor Suites shall be capable of proper operation in an ambient temperature environment of 32 degrees F to + 125 degrees F, 10 – 90 % RH.
10. Sensor Suites shall have LED indication for visual status of communication and power.

11. Sensor Suites shall operate on 24vac power fed from a common 120/24 vac transformer connected to the Sensor Suite. Transformer shall also distribute low voltage power to the Air Date Routers connected to the Sensor Suite through the associated structured cable.

K. Structured Cable

1. The FMS shall utilize a pre-engineered system of Structured Cable to facilitate network wide communications; distribution of low voltage power to Air Data Routers and Sensor Suites; and provide a sampling medium for air samples all within a single cable.
2. The cable shall consist of a plurality of wires to distribute communications, data and low voltage power throughout the FMS. As a minimum, Structured cable shall consist of:
 - a. Communications - 22ga twisted shield pair with drain wire
 - b. Low Voltage Power - 18ga, 3 wire
 - c. Discrete Sensing - 22ga, twisted pair
 - d. Future - 26ga, twisted pair
3. An inner pathway, MicroDuct, shall be furnished as an integral part of the Structured Cable to facilitate collection of test area air samples. MicroDuct shall be lined with a hardened, smooth, electrically conductive, chemically inert surface to insure air samples remain pure and uncorrupted by the wall lining and do not adhere to lining during transport.
4. Structured cable shall not require any specialized tools for installation. Installation of the cable shall follow traditional local area network practices.
5. Structured cable shall be suitable for riser and plenum applications, be Underwriter's Laboratories tested, certified and listed to UL CMR and UL CMP standards, and carry the appropriate listings throughout the cable length.

2.8 SWITCHES

A. Low Temperature Limit Switch:

1. 4-wire, two SPDT switches, main contacts open on temperature below setpoint, pilot contacts close. Auto-reset unless otherwise indicated. Extended length capillary type element with any one foot at setpoint causing trip. Freeze protection, low limit minimum range 0-60 F. Suitable for ambient temperatures -40 to 140 F. Siebe T-5232 or equal.

B. Differential Pressure Switch - Air:

1. Diaphragm operated single pole double throw snap switch. Siebe PC-301 or equal. Provide static pressure taps with integral compression fittings for reference tubing at duct penetrations.

C. Differential Pressure Switch - Liquid:

1. Brass bellows operated single pole double throw switch. Where differential pressure is 10 PSI or less provide United Electric J21K Series or equal. Where differential pressure is greater than 10 PSI provide Penn P-74FA-5 or equal. Provide with gate or ball valve isolation.

D. Glycol Tank Level Switches:

1. Insertion float type

E. Liquid Level Switches:

1. Single float, single station, magnetically actuated mercury switch contacts, flange mounted Nema 4 enclosure. Magnetrol T20 or approved equal.

F. Selector Switches:

1. Rotary switch, stackable contact blocks, 30.5 mm operator. Square D class 9001 or equal.

G. Push Button Switches:

1. Momentary contact, stackable contact blocks, 30.5 mm operator. Square D class 9001 or equal.

H. Current Sensing Switches

1. Current operated solid state switch, 0.5 to 200 amp amperage range. Mini solid-core or split-core for fixed loads. Veris or equal.
2. Current operated solid state switch with adjustable set-point from 1 to 135 amps. Power and status LED's, non-polarity sensitive. Veris or equal.

2.9 MOTORIZED CONTROL DAMPERS

A. Rectangular Dampers:

1. Provide dampers with EPDM blade edge seals and stainless steel jamb seals to guarantee maximum leakage rate of 15 CFM/sq. ft. at 4" water gauge pressure differential. Ruskin RCD46 or equal.
2. Blades of 16 gauge formed galvanized steel or two 22 gauge galvanized steel sheets spot welded together, not over 8" wide or 48" long, secured to ½" diameter zinc plated rod axles with zinc plated bolts and thrust bearings at each blade. Permanently make ends of axles to indicate blade position. Bar or channel frames of 16 gauge formed galvanized steel with holes for duct mounting.
3. Damper widths over 48" long shall be constructed of damper modules bolted and coupled together to achieve the desired dimension.
4. Suitable for operation in air-stream temperatures from -25 F to 180 F.
5. Bearings: molded synthetic.
6. Linkage: Zinc plated steel and brass.

B. Round Control Dampers:

1. Control dampers in round ductwork: 20 gauge galvanized steel frame, 14 gauge galvanized steel blade, neoprene blade seal, stainless steel sleeve axle bearing. Ruskin CDRS25 or equal.
2. Construct control dampers located in stainless steel ductwork from stainless steel.
3. Provide external bearing on removable socket type drive shafts.

2.10 CONTROL VALVES

A. General

1. Non-terminal unit control valves (½" through 3") sizes shall have cast bronze bodies with static pressure rating conforming to ANSI B16.15- 1971 250 PSIG rating. Maximum water pressure shall be 400 PSIG with 40 to 150 F water, decreasing to 321 PSIG at the maximum water temperature of 281F.
2. Valves with flanged fittings (2.5" through 6") sizes shall have cast iron bodies with static pressure rating conforming to ANSI B16.1-1975 125 PSIG rating Maximum water pressure shall be 200 PSIG with 40 to 150 F water, decreasing to 165 PSIG at the maximum water temperature of 281 F.
3. All valves shall have stainless-steel stems, brass or stainless-steel throttling plugs, bronze valve seats, and spring-loaded Teflon -cone packing. Two-way valve plugs for non-steam applications shall have composition disks.
4. All valves shall be fully modulating unless otherwise indicated. Control contractor is responsible for the selection of the proper control valves for the project including sizing, pressure rating, flow coefficient, flow characteristic, close-off rating, and actuator selection.
5. All two-way valves shall have contoured or characterized throttling plugs with linear (for steam applications) or equal- percentage flow characteristics.
6. All three-way shall have brass or stainless steel linear throttling plugs with stainless steel stems.

B. Air Quality Data Routers

1. The Air Quality Data Router shall be furnished as a complete, self contained unit, housing all electronics, air solenoid valves, sampling manifolds, firmware, and software. Unit shall be furnished with all internal devices and wiring assembled and tested at the factory.
2. Air Data Routers shall receive commands from the Sensor Suite to open the solenoid valve of each test area to be monitored while simultaneously closing all the other solenoid valves in the system. A direct path between the test area and the virtual sensors located with the Sensor Suite shall be established to draw a continuous stream of sampled air through the Structured Cable.
3. Air Data Routers shall consist of an enclosure; terminations areas for both field wiring and Structured Cable connections; a communications/processor board; high capacity solenoid valves; and sampling manifold.
4. Air Data Router shall have provisions to interface to the FMS Structured Cable. Air Data Router shall utilize an internal, factory pre-assembled air sampling manifold to interface to the on-board solenoid valves, and push to connect speed fittings for ease of interface to the Structured Cable. Romex connectors and knockouts shall be factory furnished and installed on the Router.
5. Air Data Routers shall be capable of sampling of up to four test areas. Air Data Routers shall be sized and configured with the appropriate number of air sampling solenoid valves including all hardware and software to accommodate the number of test areas noted on the plans and/or specifications.
 - a. Air Data Router shall have the capacity to sense a total of four sensor inputs that correspond to the air sampling of the respective test areas.

- b. Air Data router shall be capable of accepting universal 0-10v and 4-20mA inputs and outputs through expansion boards for interfacing to other devices and controllers.
- 6. Up to 30 Air Data Routers shall communicate on an isolated RS-485 network with the Sensor Suite.
- 7. All point data, algorithms and application software within the Air Data Routers shall be programmable from the Server. Each Air Data Router shall contain both software and firmware to receive and perform full test and cluster sequencing schemes downloaded from the Server.
- 8. Each Air Data Router shall contain a serial port for the interface with a portable computer. Air Data Router and network interrogation shall be possible through this port.
- 9. Air Data Routers shall be capable of proper operation in an ambient temperature environment of 32 degrees F to + 125 degrees F, 10 – 90 % RH.
- 10. Air Data Routers shall have LED indication for visual status of communication and power.
- 11. Air Data Routers shall operate on 24vac power fed from a common 120/24 vac transformer connected to the Sensor Suite that serves the Air Data Router. Low voltage power shall be distributed to the Air Data Routers through the associated structured cable.

2.11 DAMPER AND VALVE ACTUATORS

A. General

- 1. Where exposed to outdoor air or air temperatures lower than 50 F use provide completely weatherproof actuators with internal heaters to allow normal operation at -50 F.
- 2. Provide spring return to normal position type actuators except at variable air volume terminal units, where fail to last position actuators are acceptable.

B. Modulating Electronic Actuators

- 1. Modulating actuators for control dampers and control valves over 1 ¼” to convert electronic 1-10 VDC, or 4-20 mA analog signal to a linear, positive positioning stroke. Direct mount type with appropriate valve and damper linkage kits as needed.

C. Two-Position Electronic Actuators

- 1. Two-position actuators for valves and dampers shall be direct mount type. Provide integral, adjustable end switches as required for the application.

2.12 VARIABLE FREQUENCY DRIVES

A. General

- 1. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage.
- 2. The input power section shall utilize a full wave bridge design. The rectifiers shall convert AC line power of fixed voltage and frequency to fixed DC voltage.

3. The output power section shall change fixed DC voltage to adjustable frequency AC voltage.
4. The adjustable frequency NEMA (Type 1, 12, or 3R) drive package shall consist of a circuit breaker disconnect, an optional 2- or 3-contactor bypass, 120 V control transformer, and control circuit terminal board for digital and analog field wiring.
5. E. The Hand-Off-Auto switch, Speed Potentiometer and Adjustable Frequency Controller-Off-Bypass
6. switch shall be mounted and wired to the drive door or located on the drive keypad.
7. The entire drive package, including the bypass starter circuit, shall be UL 508C listed and coordinated with NEMA ICS 7.1. A UL 508A panel builders label does not meet this specification.

B. Construction

1. The AC Drive power converter shall be enclosed in a NEMA (Type 1, 12, or 3R) enclosure with a circuit breaker disconnect, user terminal strip connections, and optional bypass controls. The enclosure shall provide dedicated user terminals for power and control device connection.
2. Provisions shall be included for locking the disconnect in the Off position with a padlock.
3. All enclosure and heat sink fans shall be accessible from the front and shall not require the removal of the AC drive power converter for fan replacement.

C. Application Data

1. The AC Drive shall be sized to operate a variable torque load.
2. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 72 Hz.

D. Environmental Ratings

1. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and cUL standards.
2. The AC Drive shall be designed to operate in an ambient temperature from -10 to 40 °C (14 to 104 °F).
3. AC Drives in Type 3R enclosures shall be designed to operate in an ambient temperature from -10 to 50 °C (14 to 122 °F).
4. The storage temperature range shall be -25 to 65 °C (-13 to 149 °F).
5. The maximum relative humidity shall be 95%, non-condensing.
6. The AC Drive shall be rated to operate at altitudes less than or equal to 3300 ft (1000 m). For altitudes above 3300 ft (1000 m), the AC Drive should be de-rated according to drive specifications up to 10,000 ft.
7. The AC Drive shall meet the IEC 60721-3-3-3M3 operational vibration specification.
8. The AC Drive shall include an option which will ensure that the drive is Seismic Qualified to 2003 IBC Level 3 "Extreme" rating with an Importance Factor $I_p=1.5$.

E. Ratings

1. The AC Drive shall be designed to operate at the input line voltage indicated on the equipment schedule.
2. The AC Drive shall operate from an input frequency range of 60 Hz $\pm 5\%$.
3. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.

4. The efficiency of the AC Drive shall typically be 96% or greater.
5. The variable-torque rated AC Drive overcurrent capacity shall be not less than 110% for 1 minute.
6. The output carrier frequency of the AC Drive shall be programmable at 0.5, 1, 2, 4, 8 or 12 kHz. In addition, the output carrier frequency shall be modulated around the selected frequency.

F. Protection

1. Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of communication, DC-to-DC power supply, control power, and pre-charge circuit.
2. The enclosure shall provide a fully coordinated 100,000 AIC current rating marked on the enclosure nameplate, with short circuit coordination to UL 508C Power Conversion Equipment and NEMA ICS 7.1.
3. The AC Drive shall be protected against short circuits, between output phases and phase to ground.
4. The AC drive power converter shall have a ride-through function, which will allow the logic to maintain control for a minimum of one second (60 cycles).
5. For AC drives that automatically reset after a detected fault is cleared, an auto restart function will provide programmable restart attempts. The time delay before restart attempts will be 1 second, 5 seconds, 10 seconds, and then 1 minute thereafter.
6. Upon loss of the 4–20 mA analog process follower reference signal, the AC Drive shall be programmable to display a detected fault code.
7. The AC drive power converter shall have a solid-state UL 508C listed overload protective device and meet IEC 60947.
8. The output frequency shall be enabled to fold back when the drive is in an overcurrent condition.
9. There shall be three skip frequency ranges that can be programmed to a bandwidth of 0.1 to 10 Hz.

G. Adjustments and Configurations

1. The AC Drive will be factory programmed to operate all specified optional devices.
2. The acceleration and deceleration ramp times shall be adjustable from 0.05 to 999.9 seconds.
3. The memory shall retain and record run status, detected fault type, motor current, output frequency, elapsed time, mains voltage, motor thermal state, command channel, channel reference active, and status word information in the diagnostic fault history.

H. Keypad and Display Interface

1. A graphic display interface shall offer the modification of AC Drive adjustments through a membrane keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, diagnostics fault history, local control, configuration storage, and diagnostics shall be accessible.
2. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency, and motor voltage shall be listed on the drive identification portion of the LCD display.

I. Operator and Controls

1. The control power for the digital inputs and outputs shall be 24 Vdc.
2. The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.
3. Input/Output connection terminals shall be used on all logic and analog signal connections in the power converter.
4. Two voltage-free relay output contacts will be provided. One of the contacts will indicate the AC Drive detected fault status. The other contact shall indicate a drive run status.
5. The combination enclosure shall have the following operator controls depending on the options selected:
 - a. Hand-Off-Auto switch
 - b. Speed potentiometer (located either in the door or in the power converter)
 - c. AFC-Off-Bypass switch
6. The combination enclosure shall include a terminal point connection for a fire/freezestat interlock, to prevent drive (or bypass) operation. The interlock must shut down the motor in both the drive and bypass modes.

J. Serial Communication

1. The AC Drive shall have serial communications capability for Profibus, LonWorks®, Modbus®, Unitelway, Apogee® P1, Metasys® N2, Ethernet, and BACnet.

K. Drive Isolation and Bypass Contactors

1. The AC Drive shall include electrically interlocked bypass and drive output contactors, circuit breaker disconnect, control circuit transformer, and AFC/OFF/BYPASS switch.
2. The operator shall have full control of the bypass starter by operation of the AFC/OFF/BYPASS selector switch.
3. In the AUTOMATIC mode of operation the bypass contactors shall be sequenced by the 120 V autostart contact provided by the user.
4. The bypass contactor shall be de-energized to provide motor isolation during a drive ready state of operation.
5. The drive output contactor shall be de-energized during drive bypass operation.

L. Harmonic Mitigation

1. Each drive shall include a line reactor or DC bus choke to reduce power system harmonics and provide power quality protection for the internally or externally mounted drive.

PART 3 - EXECUTION

3.1 GENERAL

A. Wiring and Raceways

1. Provide wiring and raceway complying with the National Electrical Code, Division 16, State and Local Codes and Ordinances. See electrical drawings for hazardous (classified) locations.
2. Use EMT, metal duct, IMC, rigid conduit, surface metal raceways, or totally enclosed metal through with flexible metal tubing as required by the location, Division 16, or the specifications.
3. Provide wire with copper stranded conductors. Provide color or number coded jackets.
4. Provide 20 gauge minimum foil-shielded cable rated 100 VDC at 80 C. for input/output wiring
5. Provide communications network wiring meeting the gauge, impedance, capacitance, resistance and shielding requirements specified by the manufacturer of the connected devices.
6. Plenum rated cable is acceptable in concealed, accessible areas such as suspended ceilings.
7. Install wiring in a neat an orderly manner generally running piping and wiring along building lines.
8. Seal conduit penetrations at rated walls with fire-stopping installed in accordance with fire-stopping manufacturers UL listed installation requirements.
9. Wire all electrical controls and switches furnished under this Section of the Specifications.
10. Support and conceal wiring in finished areas.

B. Air Quality Monitoring System Installation

1. Wiring
 - a. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 16 sections of these specifications.
 - b. All wiring shall be installed neatly and professionally, in accordance with requirements of applicable Specification Division 16 and all national, state, and local electrical codes. All the wiring shall be installed in accordance with the current National Electrical Code (NEC).
 - c. Provide wiring as required by functions as specified and as recommended by equipment manufacturer to serve specified control functions.
 - d. Install wiring and cables according to Division 16.
 - e. All exposed control wiring shall be installed in raceways.
 - f. Rigid conduit shall not be required for the Structured Cable. For Structured Cable that drops below 10 feet, conduit may be used for protection.
2. Control Device Installation
 - a. All Air Quality room sensors shall be mounted so as to be accessible.

- b. Enclosures and panels mounted directly to the wall shall be provided with a minimum airspace of 1" between the enclosure and the wall.
 - c. A minimum of 3' working clearance shall be provided in front of all enclosures and panels; clearance shall be ensured to permit the enclosure door to open at least 90° from its closed position.
 - d. Mounting height shall be a maximum 6'-6" to the top of the enclosure.
- 3. Control Power
 - a. Power supply for Air Data Routers, Sensor Suites, Server and associated Air Quality monitoring system components shall be connected via a dedicated circuit to the building normal electrical distribution panel. A grounding conductor shall be run from building service entrance panel ground bus. Conductor shall be insulated and isolated from other grounded conductors and building conduit system.
- 4. Interface with Direct Digital Control (DDC) System
 - a. The Air Quality monitoring system shall provide the necessary hard-wired outputs to the DDC system as required. Coordinate with the DDC system contractor as required.
 - b. Air quality will be monitored for CO, CO₂, Small Particles, and TVOC's, The DDC system shall monitor dry contacts that indicate alarm conditions for the monitored elements to execute demand control ventilation routines.
 - c. Acceptance of Completed Installation
 - d. Perform all necessary calibration, testing, and debugging operations. An acceptance test shall be performed in the presence of the Project Representative. Acceptance test shall be scheduled with at least 72 hours in advance. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - e. After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 - f. Demonstrate compliance with specifications, including calibration and testing, and air sampling test sequences. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
 - g. The acceptance test shall include, but not be limited to:
 - 1) Verification of the proper operation of all input/outputs.
 - 2) Verification that inputs meet or exceed manufacturer's stated tolerances for accuracy.
 - 3) Verification that all on-line graphical displays of air sampling test data accurately represent the real time state of the field conditions.
 - 4) Verification that of the communications reliability of all Air Data Routers and Sensor Suites.
 - 5) The test shall include functional verification of all interfaces and system integration required to meet the scope of this project.
 - h. Acceptance: When the field test procedures have been successfully demonstrated to the Project Representative and the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty.
- 5. Training

- a. Provide factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of the system. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The training shall be specifically oriented to the system and interfacing equipment installed.
- b. Instructions shall include 2 parts, the “New Equipment Orientation” and the “Product Training”.
- c. New Equipment Orientation: A “walk-through” session shall include showing where all field equipment is located throughout the area involved in the project.
- d. Product Training: Shall train designated staff to adjust, operate, and maintain the Air Quality monitoring system. Provide a minimum of 4 hours for this session.
 - 1) Train personnel on procedures and schedules for starting and stopping test sequences, troubleshooting, servicing, and maintaining equipment.
- e. Provide a student binder with training modules.

3.2 COORDINATION

- A. Coordinate this work with the work of other trades, and make arrangements for the complete and proper accomplishment of all related work. Coordinate required control interlocks with HVAC manufacturers or local representatives as necessary.
- B. Mechanical Subcontractor Responsibilities
 - 1. Installs automatic valves and separable wells that are supplied by the temperature control contractor.
 - 2. Provides pressure taps, distribution systems connections, and piping.
 - 3. Provides piping connections required for flow devices.
- C. Sheetmetal Subcontractor Responsibilities
 - 1. Installs all automatic dampers and airflow measuring stations. Provides blank-off plates or transitions required to install devices that are smaller than duct size.
 - 2. Assembles multiple section dampers with required interconnecting linkages and extends required number of shafts through duct for external mounting of damper motors.
 - 3. Provides and installs access doors or other approved means of access through ducts for service to control equipment.

3.3 TESTING AND ADJUSTING

- A. Upon completion of the control installation start up the system, perform necessary testing, and adjust the system to ensure proper operation.
- B. Coordinate the final adjustments and “fine tuning” of control functions and devices so the mechanical systems and the control systems operate and respond as an integrated comfortable and energy efficient component of this facility.

3.4 ORIENTATION AND TRAINING

- A. Provide 8 hours of orientation and field training on the DDC system to the Owner's personnel after final completion and acceptance of the project.

3.5 SEQUENCE OF OPERATION

A. AHU-1, (Existing, Reference Only)

1. General: AHU-1 supply and return fans and FTU fans shall be started and stopped from the DDCS on a programmed 7 day occupied/unoccupied schedule and optimal start program. AHU dampers shall go to the appropriate position as described below; supply and return fans shall start simultaneously. Air terminal dampers shall all open to minimum position one minute prior to AHU fan start. On AHU shutdown, the outside air damper and exhaust damper shall completely close, the recirculation damper shall fully open, and both the supply and return fans shall stop.
2. Morning Warm Up: Prior to the scheduled occupied hour, if three or more zone space temperature sensors are below 70°F the following warm-up sequence shall occur:
 - a. Lead time for this sequence shall be calculated by the DDCS optimal start program based on space temperature, outside air temperature, time of day, and historic trend data.
 - b. During this mode the supply and return fans shall remain off, the outside air damper and exhaust damper shall remain closed. The recirculation damper shall be open.
 - c. The associated system FTU's shall start. The FTU motorized supply air damper shall remain in minimum position and each FTU heating coil shall stage on to provide a warm up period.
 - d. When the associated space temperature reaches 70°F (adjustable), the FTU damper shall modulate to its minimum setting. When all spaces have reached their setpoints, the air handling unit's outside air damper and exhaust air dampers shall modulate to the minimum outside air position, the supply and return fans shall start, and DDCS shall maintain supply air temperature setpoint per the occupied mode.
3. Occupied Mode: The occupied mode shall be enabled after the end of warm-up period. The variable speed supply fan shall be started based on the occupancy schedule and the optimal start program. When the supply fan status indicates the fan has started, the occupied mode control sequence shall be enabled as follows:
 - a. AHU Supply Fan: The DDCS shall modulate the supply fan VFD to maintain a duct static pressure of 1.25 "w.c. (adjustable). The DDCS shall reset static pressure setpoint so that one FTU terminal damper is wide open while satisfying its primary air flow requirement.
 - b. AHU Return Fan: After the supply fan has been started, the variable speed return fan shall be started. The DDCS shall modulate the return fan VFD to maintain a continuous offset in fan speed as measured by DDCS using the speed reference output of the supply and return fan VFD's.
 - c. AHU Occupied Cooling Mode: The DDCS shall modulate the outside air damper as necessary to maintain supply air temperature cooling setpoint. The exhaust air

damper shall track the same position as the outside air damper and the return air damper shall track opposite the outside air damper. When the outside air damper is at minimum outside air volume, the return damper shall modulate to maintain a static pressure in the mixed air plenum of -0.03 inches water column relative to outside. The fresh air intake of the unit will be limited to prevent the mixed air temperature from falling below the low limit setpoint.

- d. AHU Occupied Heating Mode: The DDCS shall close the outside air damper to minimum position, the exhaust air damper shall track the outside air damper and the return air damper shall be full open utilizing return air as the heating source. When the discharge air setpoint can not be satisfied by utilizing the return air, the duct mounted electric heating coil shall be modulated to maintain the discharge air heating setpoint. The discharge air temperature setpoint shall be reset from the zones as their temperature requirements change.
- e. Fan Terminal Units: Terminal unit controls shall operate the fan continuously and maintain constant fan airflow during occupied hours. Primary air damper on FTU shall modulate between scheduled minimum airflow and scheduled maximum airflow to maintain room cooling setpoint. Heating coil shall be off. When room temperature falls below setpoint, primary air damper shall be at minimum position and heating coil shall be staged by the terminal unit heat controller using an analog signal from the DDCS controller to maintain room setpoint.
- f. Fan Terminal Units With Electric Baseboard Heaters: Terminal unit controls shall operate the fan continuously and maintain constant fan airflow during occupied hours. Primary air damper on FTU shall modulate between scheduled minimum airflow and scheduled maximum airflow to maintain room cooling setpoint. FTU heating coil and baseboard heaters shall be off. When room temperature falls below setpoint, primary air damper shall be at minimum position and heating coil shall be staged to maintain room setpoint. If setpoint can not be maintained through the FTU then the electric baseboards EB-1 and EB-2 shall be energized as the second stage of heating. Each office shall have a separate room temperature sensor for individual control over its electric baseboard heater which will sequence on as the second stage of heat.
- g. Men's Locker Room: Primary air damper on VAV-4 shall modulate between scheduled minimum airflow and scheduled maximum airflow to maintain room cooling setpoint. VAV heating coil and EC-1 heaters shall be off. When room temperature falls below setpoint, primary air damper shall be at minimum position and the electric heating coil shall stage on to maintain room setpoint. If setpoint can not be maintained through the VAV unit then the electric ceiling heaters EC-1, 2 shall be energized as the second stage of heating. VAV -4 and EC-1, 2 heaters shall remain off during unoccupied mode.

4. Unoccupied Mode:

- a. The unoccupied mode shall be enabled from the DDCS time schedule. During unoccupied mode AHU-1 fans shall be off, the outside air damper and exhaust damper shall be closed and recirculation damper shall be open. The unit shall remain off during unoccupied mode unless the unit is started by the bypass timer.
- b. When the temperature in a space served by an FTU falls below 63°F, the AHU shall remain in shutdown mode and the associated space FTU fan motor shall be started. The FTU primary air damper shall be in minimum position and the FTU heating coil shall be staged. When the space temperature reaches 68°F, the heating

coil shall be turned off and the FTU fan motor stop. Electric baseboard heaters shall remain off during unoccupied mode.

- c. Room temperature sensors are to be equipped with an unoccupied override switch. Activation of this switch shall cause the associated FTU to start and run per the normal occupied sequence for a period of two hours. After two hours has elapsed without re-activation of the override switch, the FTU shall return to the normal unoccupied sequence.
- d. Provide a master override bypass switch with label in the Reception Area. When master override switch is enabled, AHU-1 and associated terminal units shall go to occupied mode for a period of two hours. When override period has ended, AHU-1 and associated terminal units shall go to unoccupied mode.

5. Safeties: The following safeties shall be provided:

- a. Upon a loss of airflow or VFD fault alarm is activated the system shall shutdown. The system shall automatically restart when the VFD fault input is cleared and airflow has been proven.
- b. Signal from fire alarm shall stop the supply and return fans and close the outside air and exhaust air dampers. System shall be capable of being commanded to 100% outside air operation from the fire alarm control panel. System shall automatically restart upon reset of fire alarm panel.
- c. DDCS shall monitor air filter differential pressure sensor and provide an operator alarm for dirty filter status.
- d. DDCS shall shut air handling system down on a rise in supply duct static pressure to 3.0" w.c. and provide operator alarm.

B. AHU-3

1. Occupied mode:

- a. Supply Fan Control: The variable speed supply fan shall be started based on the occupancy schedule and the optimal start program. After the start command is sent, the outside air damper shall open, and the unit shall start when the damper end switch has proven open status. When the supply fan status indicates the fan has started, the occupied mode control sequence shall be enabled. A high limit static pressure switch located downstream of the supply fan shall shut the system down and alarm the DDCS upon reaching the high limit pressure setpoint. Upon a loss of airflow, the supply fan shall automatically restart. When the supply fan variable frequency drive fault input is activated, the system shall shutdown. When the fault condition clears, the system shall restart as required.
- b. Exhaust Fan Control: After the supply fan has been started, the exhaust air damper shall open, and the variable speed exhaust fan shall start when the damper end switch has proven open status. The exhaust fan shall modulate in conjunction with the supply fan. When the exhaust fan frequency converter fault input is activated, the system shall shutdown. When the fault condition clears, the system shall restart as required.
- c. Heat Recovery Control: The single speed heat recovery wheel shall be enabled when the absolute value of the difference between the exhaust air temperature and the outdoor air temperature is greater than the heat recovery setpoint. On a drop in outdoor air temperature below the heat recovery low limit setpoint, the heat recovery wheel shall cycle off. Once the temperature increases above the setpoint

plus the differential, the heat recovery wheel shall automatically cycle back on. Upon a loss of heat recovery wheel status, the heat recovery wheel shall automatically restart. An alarm shall be sent to the DDCS if the heat recovery wheel fails to restart.

- d. **Temperature Control:** If the discharge air temperature setpoint can not be maintained by the heat recovery wheel, the electric reheat coil shall be staged on to maintain the discharge air temperature setpoint. The discharge air temperature setpoint shall be reset on a linear schedule as the outdoor temperature changes. In the cooling season, the unit shall operate to provide ventilation only with the heat recovery wheel and reheat coil turned off. Provide space temperature sensors in the Bay Area for monitoring. If any space temperature drops below low limit setpoint an alarm shall be reported to DDCS.
- e. **Maintenance Area:** When the total volatile organic compound (TVOC) concentration is less than 1 ppm and the Carbon Monoxide (CO) concentration is less than 25 ppm as measured by the Air Quality Monitor System, the system outside air damper shall open to 50% airflow as measured by the damper's airflow sensing elements. On a rise in TVOC concentration to 3 ppm or CO to 35 ppm, the outside air damper shall open to 100% airflow. System shall stay in this 100% outside air mode until five minutes after the TVOC concentration has been maintained at below 1 ppm and the CO concentration has been maintained below 25 ppm.
- f. The system exhaust damper shall track the same position as the system outside air damper and the recirculation damper shall track opposite the system outside air damper.
- g. Upon a loss of signal from the Air Quality Monitoring System, the DDC System shall set the outside air and exhaust air dampers to full open position and the recirculation damper to full closed position and initiate alarm.
- h. When the absolute value of the difference between the exhaust air inlet temperature and the outside air temperature is greater than 4.5 F degrees, the exhaust air heat recovery wheel bypass damper shall be closed and the intake air heat recovery wheel bypass damper shall be closed. When the difference is less than or equal to 4.5 F degrees, the intake air heat recovery wheel bypass damper shall open and the exhaust air heat recovery wheel bypass damper shall open.
- i. When the exhaust air inlet temperature is 10 F degrees (adjustable) above the heating setpoint temperature, and 5 F degrees (adjustable) greater than the outside air temperature, both heat recovery wheel bypass dampers shall open, the recirculation damper shall close, the heat recovery wheel shall stop, and the radiant floor heating system shall be disabled.

2. Unoccupied Mode:

- a. The unoccupied mode shall be enabled from the DDCS time schedule. During unoccupied mode AHU-3 fans shall be off, the outside air damper and exhaust damper shall be closed and the heat recovery wheel and the electric reheat coil shall be off. The unit shall remain off during unoccupied mode unless the unit is started by the bypass timer.
- b. An unoccupied mode override switch located in the corridor outside Lunch/Training Room 143 shall enable AHU-3 to go to the occupied mode for a period of 2 hours. When override period has ended, AHU-3 shall revert to unoccupied mode.

3. Safeties: The following safeties shall be provided:
 - a. Upon a loss of airflow or VFD fault alarm is activated the system shall shutdown. The system shall automatically restart when the VFD fault input is cleared and airflow has been proven.
 - b. Signal from fire alarm shall stop the supply and return fans and close the outside air and exhaust air dampers. Systems shall be capable of being commanded into 100% outside air operation from the fire alarm control panel. Systems shall automatically restart upon the reset of fire alarm panel.
 - c. DDC system shall monitor air filter differential pressure sensor and provide an operator alarm for dirty filter status.
 - d. DDC system shall shut air handling system down on a rise in supply duct static pressure to 3.0" w.c. and provide operator alarm.
 - e. If outside air or exhaust air damper fail to open when commanded the unit shall be shut down and provide operator alarm.

C. Heating Water Boiler B-2:

1. The DDCS shall enable Boiler B-2 when the outside air temperature falls below 58°F or on a call for heat. Upon verification that the DDCS has not received any alarms from the Boiler integral control panel, the DDCS shall start and operate the Hot Water System as follows:
 - a. The DDCS shall start boiler circulation pump P-4. Upon proof of flow, the Boiler shall start. Upon pump failure the DDCS shall stop the Boiler and pump from operating and send an alarm to the DDCS. The pump shall restart after the system reset is activated.
 - b. When the Boiler starts, the Boiler electric heating elements shall be staged via its own internal controls to maintain leaving water temperature setpoint.
 - c. Upon receiving an alarm condition from the Boiler, the DDCS shall shut down the Boiler and Pump P-4. Upon boiler shut down, Pump P-4 shall continue operating for 5 minutes to dissipate the heat from the boiler.
 - d. After all calls for heat have been satisfied, the DDCS shall maintain the Boiler enable status for 20 minutes or until the outside air temperature rises above 60°F

D. Radiant Floor Heating System:

1. Occupied Heating Mode:
 - a. The DDCS shall enable the Radiant Floor Heating System upon verification that Boiler B-2 and Pump P-4 are operating as required and there is a call for heating from the zone space or slab temperature sensor.
 - b. When enabled, The DDCS shall open the manifold control valves to allow water flow to the zones requiring heating. When the zone manifold control valve is open its associated Radiant Floor Circulating Pump shall start. Upon pump failure the DDCS shall send an alarm to the DDCS. The pump shall restart after the system reset is activated.
 - c. Each Radiant Zone shall be controlled from a 3-Way mixing control valve. The DDCS shall supply a signal to each control valve to adjust set point temperature over a 20°F (adjustable) temperature range to maintain supply slab heating water

- temperature at set-point. Generate a System alarm if supply heating water temperature to slab exceeds 130°F (adjustable).
 - d. Control the slab heating-water supply temperature in a straight-line relationship with outside air for the following conditions (adjustable):
 - 1) 120°F slab heating water when outside temperature is 20°F.
 - 2) 90°F slab heating water when outside temperature is 60°F.
 - e. Provide control logic for heating mode to anticipate zone space temperature changes in response to radiant slab heating in order to minimize overshoot. DDCS shall close control valves to stop water flow to slab in applicable zone(s) when satisfied. When the zone valve is closed the associated Radiant Floor Circulating Pump shall shut off.
2. Unoccupied Heating Mode:
- a. The radiant floor heating is controlled using the same control sequence as occupied mode but using the unoccupied space temperature set point. The controller shall reset to the occupied mode for a predetermined time period upon a signal from the control system.
3. Morning Warm-Up Sequence:
- a. Provide morning warm-up sequence during the heating season that is designed to bring zone temperatures up to occupied set-point at the start of zone occupied period each day, in accordance with occupancy schedule.
4. DDCS Alarms
- a. Generate separate alarms at the operator workstation for the following conditions:
 - 1) Pump flow failure
 - 2) Under-heating: Space temperatures are below set-point by 4°F for more than 10 minutes during occupied heating mode.
 - 3) Overheating: Space temperatures are above set-point by 4°F for more than 10 minutes during occupied heating mode.
 - 4) Supply hot water temperature to zone exceeds set-point by more than 10°F for more than 5 minutes.
- E. Exhaust Fan EF- 3:
- 1. DDC shall start/stop Exhaust Fan, which shall normally operate continuously.
 - 2. DDC system shall monitor status of fan through current sensor calibrated to indicate fan failure.
 - 3. Provide alarm at GUI equipment graphic and at alarm log: if fan status is on and fan is not commanded on or if fan status is off and fan is commanded on.
- F. Sign Shop EF-5:
- 1. EF-5 shall be operated by manual on/off switch mounted on wall in the space.
- G. Sign Shop HC-1:

1. HC-1 shall be energized based on room temperature sensor to maintain the space temperature to 70 deg F (adjustable).

3.6 GRAPHICS

- A. Graphics screens shall be created for each discrete mechanical system controlled by the DDC system. The following minimum graphics shall be included:

1. Building floor plans indicating zones of air handling unit coverage
2. Building floor plans indicating zone temperatures
3. AHU's, FTU's, VAV units, EF's
4. Boiler, circulating pump, radiant heating system
5. Building floor plan graphic showing the controller network routing

- B. The following features shall be incorporated into the graphical user interface:

1. Final balanced setpoints (such as minimum outside air damper position, duct static pressure and differential pressure) in text on equipment graphics so operators can easily return setpoints to their original values
2. Reset schedules in text on equipment graphics so operators can understand the system
3. Final room numbers/names served by equipment, like exhaust fans & FTU/VAV boxes
4. Location of all "minor" equipment and remote sensors (like EF's, AC units, duct heaters, HC, differential pressure etc.) on floor plans with links to equipment from floor plan
5. Place interlocked equipment on same graphic or note interlocked equipment in text with link to interlocked equipment if it cannot fit on same graphic
6. Other text as needed to make operation of system clear to operators from graphics
7. Building floor plans showing location of mechanical equipment and areas served
8. All setpoints and device commands shall be adjustable from unit graphics without going into additional screens. Password protection must be set-up, to meet the owner's requirements, that limits different levels of operation staff from changing these setpoints
9. Each equipment graphic needs to include setpoints and all monitored points
10. Links between each graphic for easy and quick navigation between screens
11. Points and data shown on graphics shall reflect actual conditions
12. Graphics shall indicate on the equipment screen if a point is overridden. A change of color would be an acceptable indicator.
13. Graphics and wording shall be user friendly and easily understood by personal with minimum controls training. Data provided shall give an operator, with a basic understanding of HVAC systems, the parameters and data needed for troubleshooting and understanding the system without having to look at the control logic.
14. Screen of schedules which indicate which equipment is tied to each schedule and allows easy updating of schedules and ability to change which equipment is on each schedule.
15. Alarms shall be shown graphically on the relevant equipment device – this can be in the form of a color change. For example: Freezestat shall show as in alarm on air-handling unit screens.
16. If occupancy sensors are used in sequences, the operator should be able to override the occupancy sensor at the equipment graphic so the HVAC can continue to operate if the sensor fails or needs to be replaced

3.7 POINTS LIST

- A. The following points list provides information that is supplemental to the sequences of operation described above. In the event of there being a conflict between the points list and the sequence of operations, the sequence of operations shall govern.
- B. All input points indicated below shall be monitored by the DDC system regardless of whether they are indicated in the sequence of operations.

<u>City/Borough of Juneau</u> <u>ENERGY MANAGEMENT AND CONTROL SYSTEM</u> Consolidated Public Works Facility					
Building Control System Point Summary					
<u>Air Handling Unit (AHU-1), Existing, Listed only for reference</u>					
	<u>Digital Outputs</u>	<u>Digital Inputs</u>	<u>Analog Outputs</u>	<u>Analog Inputs</u>	<u>Remarks</u>
Supply fan VFD start/stop	X				
Supply fan VFD proof		X			
Supply fan VFD Speed Control			X		
Supply fan VFD alarm		X			
Supply fan VFD Speed				X	
Filter Differential Pressure Sensor				X	
Hi Static Pressure Switch		X			
Electric Heating Coil			X		SCR
Discharge Air Temperature				X	
Exhaust Dampers			X		
Outside Air Damper			X		
Recirculating Damper			X		
Mixed Air Temperature				X	
Mixed Air Plenum Static Pressure				X	Reference to outside
Return Air Temperature				X	
Return fan VFD Start/stop	X				
Return fan VFD Proof		X			
Return fan VFD Speed Control			X		
Return fan VFD Alarm		X			
Return fan VFD Speed				X	
Duct Static Pressure Sensor				X	Duct Static Pressure Sensor
Manual Override Timer Switch	X			X	

Fan Powered and VAV Terminal Units					
	<u>Digital Outputs</u>	<u>Digital Inputs</u>	<u>Analog Outputs</u>	<u>Analog Inputs</u>	<u>Remarks</u>
Space Temperature Sensor				X	
Bypass Override Switch		X			
Fan Stop/Start	X				FTU Only

Primary Air Flow Damper			X		
Air Flow CFM				X	
Electric Heating Coil			X		
Discharge Air Temperature				X	
Air Handling Unit (AHU-3)					
	<u>Digital Outputs</u>	<u>Digital Inputs</u>	<u>Analog Outputs</u>	<u>Analog Inputs</u>	<u>Remarks</u>
Supply fan VFD start/stop	X				
Supply fan VFD proof		X			
Supply fan VFD Speed			X		
Supply fan VFD alarm		X			
Supply fan VFD Speed Control				X	
Supply Filter Differential Pressure Sensor				X	
Exhaust Filter Differential Pressure Sensor				X	
Heat Recovery Wheel Leaving Exhaust Air Temp Sensor				X	
Electric Heating Coil			X		SCR
Discharge Air Temperature				X	
Exhaust Damper	X				
Exhaust Damper Position Indication Sensor		X			
Outside Air Damper	X				
Outside Air Damper Position Indication Sensor		X			
Heat Recovery Wheel Start/Stop	X				
Heat Recovery Wheel Proof		X			
Heat Recovery Wheel Alarm		X			
Heat Recovery Wheel Exhaust bypass damper	X				
Heat Recovery Wheel OA bypass damper	X				
Space Temperature Sensors				X	
Exhaust Air Temperature Sensor				X	
Exhaust fan VFD Start/stop	X				
Exhaust fan VFD Proof		X			
Exhaust fan VFD Speed Control			X		
Exhaust fan VFD Alarm		X			
Exhaust Air Duct Static Pressure Lo Limit Switch		X			
Supply Air Duct Static Pressure Sensor					
Supply Air Duct Static Pressure Hi Limit Switch		X			
Building Static Pressure Sensor				X	Reference to outside
Return Smoke Detector		X			
Supply Smoke Detector		X			
Outside Air Temperature Sensor				X	
Manual Override Timer Switch		X			
AQMS			X	X	Coordinate point type with the Aircuity rep

Boiler & Heating Water Pump					
	<u>Digital Outputs</u>	<u>Digital Inputs</u>	<u>Analog Outputs</u>	<u>Analog Inputs</u>	<u>Remarks</u>
Hot Water Pump P-4 stop/start	X				
Hot Water Pump P-4 Proof		X			
Flow Switch		X			
Hot Water Pump P-4 Alarm		X			

Boiler Enable / Disable	X				
Boiler Alarm		X			
Boiler Leaving Water Temperature				X	
Boiler Entering Water Temperature				X	
Outside Air Temperature				X	
Boiler Reset			X		Coordinate with the boiler supplier

Radiant Floor Heating System

	<u>Digital Outputs</u>	<u>Digital Inputs</u>	<u>Analog Outputs</u>	<u>Analog Inputs</u>	<u>Remarks</u>
Radiant Floor Pump P-5 stop/start	X				
Radiant Floor Pump P-5 proof		X			
Radiant Floor Pump P-5 Alarm		X			
Radiant Floor Pump P-6 stop/start	X				
Radiant Floor Pump P-6 proof		X			
Radiant Floor Pump P-6 Alarm		X			
Radiant Floor Zone 1 Flow		X			
Radiant Floor Zone R-1 Manifold Valve Open/Close	X				
Radiant Floor Zone R-1 HW Mixing Valve			X		
Radiant Floor Zone R-1 Slab Temperature Sensor				X	
Radiant Floor Zone R-1 Space Temperature Sensor				X	
Radiant Floor Zone R-2 Flow		X			
Radiant Floor Zone R-2 Manifold Valve Open/Close	X				
Radiant Floor Zone R-2 HW Mixing Valve			X		
Radiant Floor Zone R-2 Slab Temperature Sensor				X	
Radiant Floor Zone R-2 Space Temperature Sensor				X	

Exhaust Fans EF- 3 and 5

	<u>Digital Outputs</u>	<u>Digital Inputs</u>	<u>Analog Outputs</u>	<u>Analog Inputs</u>	<u>Remarks</u>
Exhaust fan stop/start	X				EF-3 only
Exhaust fan status		X			

Electric Baseboard Heaters EB-1 and 2

	<u>Digital Outputs</u>	<u>Digital Inputs</u>	<u>Analog Outputs</u>	<u>Analog Inputs</u>	<u>Remarks</u>
Room Temperature Sensor				X	
Heater On/Off	X				

Miscellaneous Points

	<u>Digital Outputs</u>	<u>Digital Inputs</u>	<u>Analog Outputs</u>	<u>Analog Inputs</u>	<u>Remarks</u>
Maintenance Bay Area Air Quality Sensor (Aircuity System)				X	Coordinate point type with the Aircuity rep
Bay Area Remote Warning Beacon	X				
Beam Photocell Sensors (Aircuity System)		X			Typical Each Beam Detector in Sequence of Operations (Coordinate with Aircuity Rep)

END OF SECTION 15975

SECTION 16050 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following electrical materials and methods:

1. Supporting devices for electrical components.
2. Concrete equipment bases.
3. Electrical identification.
4. Electrical demolition.
5. Cutting and patching for electrical construction.
6. Touchup painting.
7. Meter sockets.

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of Section 01300 – CONTRACTOR Submittals.
- B. Provide catalog cut sheets providing product data for each type of product specified. Note specifically what component is being submitted when more than one model or version is shown on the cut sheet. Where there is more than one of each type of component (circuit breaker), label the top of each cut sheet with the specific component that the cut sheet applies to.
- C. Provide Shop Drawings detailing fabrication and installation of supports and anchorage for electrical items. Show all components of a system and how they relate to each other during installation. Include details of mounting brackets, wiring interconnections, single line diagrams, component layout diagrams for enclosures, materials lists for components in enclosures, wiring schematic diagrams with each wire numbered and each terminal numbered for wiring in enclosures.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70 for components and installation.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.4 SEQUENCING AND SCHEDULING

- A. Coordinate electrical equipment installation with other trades.
- B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.
- C. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the WORK.
- E. Coordinate connecting electrical systems with exterior underground utilities and services. Comply with requirements of governing regulations, utility requirements, and controlling agencies.
- F. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.
 - 1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.
 - 2. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel, or type 316L stainless steel, except as otherwise indicated.

- B. Steel channel supports have 9/16-inch (14-mm) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least 1 surface.
 - 1. Fittings and accessories mate and match with channels and are from the same manufacturer.
- C. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, fiberglass-resin channels and angles with 9/16-inch (14-mm) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least 1 surface.
 - 1. Fittings and accessories mate and match with channels or angles and are from the same manufacturer.
 - 2. Fitting and Accessory Material: Same as channels and angles, except metal items may be stainless steel.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps or "click"- type hangers.
- E. Sheet-Metal Sleeves: 0.0276-inch (0.7-mm) or heavier galvanized sheet steel, round tube, closed with welded longitudinal joint.
- F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- G. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable iron casting with hot-dip galvanized finish.
- H. Expansion Anchors: Red Head, Hilti, or equal. Stainless steel. When mounting devices to concrete, use Hilti products designed for that purpose.
- I. Toggle Bolts: All-steel springhead type.
- J. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 ELECTRICAL IDENTIFICATION

- A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Raceway and Cable Labels: Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.
 - 1. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.
 - 2. Color: Black legend on orange field.

3. Legend: Indicates voltage.
- C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch wide (0.08 mm thick by 25 mm wide).
 - D. Underground Line Warning Tape: Permanent, bright-colored, detectable, continuous-printed, vinyl tape with the following features:
 1. Size: Not less than 4 mils thick by 6 inches wide.
 2. Compounded for permanent direct-burial service.
 3. Embedded continuous metallic strip or core.
 4. Printed legend that indicates type of underground line.
 - E. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
 - F. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
 - G. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched for mechanical fasteners 1/16-inch (1.6-mm) minimum thick for signs up to 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick for larger sizes. Engraved legend in black letters on white face.
 - H. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.3 TOUCHUP PAINT

- A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.
- B. For Nonequipment Surfaces: Matching type and color of undamaged, existing adjacent finish.
- C. For Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

- A. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.
- B. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.

- C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Give right of way to raceways and piping systems installed at a required slope.
- E. Coordinate with all other trades to install electrical equipment without being in conflict with other work. Where devices or equipment is in conflict, work out a solution that accommodates both trades and coordinate solution with owner's representative. Do not change the design without the engineer's approval.
- F. Keep all equipment in a dry, heated, secure storage area prior to installation. After installation, all equipment shall be kept dry and above 55 degrees Fahrenheit. If the building can not be kept that warm, do not install any equipment with microprocessors, any access control equipment, any fire alarm equipment, any video equipment, or any telephone/data/television equipment.
- G. Label the cover of all interior junction boxes with the circuit nos. of the wiring they contain. Label all conductors and cables in exterior junction boxes with the circuit no. and description of the circuit i.e., STREET LTG.

3.2 ELECTRICAL SUPPORTING METHODS

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components. Consider the exterior of the building a damp location.
- B. Support Clamps for PVC Raceways: Click-type clamp system.
- C. Conform to manufacturer's recommendations for selecting supports.
- D. Strength of Supports: Adequate to carry all present and future loads, times a safety factor of at least 4; 200-lb- (90-kg-) minimum design load.

3.3 INSTALLATION

- A. Install devices to securely and permanently fasten and support electrical components.
- B. Raceway Supports: Comply with NFPA 70 and the following requirements:
 - 1. Conform to manufacturer's recommendations for selecting and installing supports.
 - 2. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 3. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
 - 4. Spare Capacity: Size supports for multiple conduits so capacity can be increased by a 25 percent minimum in the future.

5. Support individual horizontal raceways with separate, malleable iron pipe hangers or clamps.
 6. Hanger Rods: 1/4-inch (6-mm) diameter or larger threaded steel, except as otherwise indicated.
 7. Spring Steel Fasteners: Specifically designed for supporting single conduits or tubing. May be used in lieu of malleable iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to channel and slotted angle supports.
 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports, with no weight load on raceway terminals.
- C. Vertical Conductor Supports: Install simultaneously with conductors.
- D. Miscellaneous Supports: Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices except where components are mounted directly to structural features of adequate strength.
- E. Sleeves: Install for cable and raceway penetrations of concrete slabs and walls, except where core-drilled holes are used. Install for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- F. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:
1. Fasten by means of wood screws or screw-type nails on wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on concrete or solid masonry; and by machine screws, welded threaded studs, or spring-tension clamps on steel.
 2. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts, machine screws, or wood screws.
 3. Drill holes in concrete beams so holes more than 1-1/2 inches (38 mm) deep do not cut main reinforcing bars.
 4. Drill holes in concrete so holes more than 3/4 inch (19 mm) deep do not cut main reinforcing bars.
 5. Fill and seal holes drilled in concrete and not used.
 6. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.
- G. Install identification devices where required.
1. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
 2. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated on the contract

documents or required by codes and standards. Use consistent designations throughout the Project.

3. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
 4. Tag or label power circuits for future connection and circuits in raceways and enclosures with other circuits. Identify source and circuit numbers in each cabinet, pull box, junction box, and outlet box. Color coding may be used for voltage and phase indication.
 5. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above power and communication lines. Locate 6 to 8 inches (150 to 200 mm) below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches (400 mm), use a single line marker.
 6. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.
- H. Store all material and equipment in a dry, heated area until it is installed. Keep all material dry and if it has printed circuit boards or any other electronic components, keep it in a dry heated location after it is installed.

3.4 DEMOLITION

- A. Where electrical WORK to remain is damaged or disturbed in the course of the WORK, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Keep all existing electrical systems on the project site fully operational during the course of the WORK

3.5 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.
- B. Repair disturbed surfaces to match adjacent undisturbed surfaces.

3.6 TOUCH-UP PAINTING

- A. Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.
- B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

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END OF SECTION 16050

SECTION 16120 – CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- B. Catalog Cut Sheets: Provide product data on all equipment including installation instructions.
- C. Shop Drawings: Provide numbering scheme on a set of floor plans with all devices shown and on elevation drawings showing the patch panels with appropriate numbering at each jack in panel.

1.2 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NFPA 70, IBC, NESC, and all local, state, and federal regulations.
- C. All telephone and data communications cabling, materials, and installation practices shall comply with the applicable sections of the following Telecommunications Industry Standards:
 - 1. ANSI/TIA/EIA-568-B.1-2001, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.
 - 2. ANSI/TIA/EIA-568-B.2-2001, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components.
 - 3. ANSI/TIA/EIA-568-B.2-1-2002, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components.
 - 4. ANSI/TIA/EIA-568-B.3-2000, Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standard.
 - 5. ANSI/TIA/EIA-569-A-2001 (Including 5 addendums), Commercial Building Standards for Telecommunications Pathways and Spaces
 - 6. ANSI/EIA/TIA-570-1991, Residential and Light Commercial Telecommunications Wiring Standard
 - 7. ANSI/TIA/EIA-606-1993, The Administration Standard for the Telecommunications infrastructure of Commercial Building
 - 8. ANSI/TIA/EIA-607-1994, Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26.

1.4 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by ENGINEER.

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Wires and Cables:
 - a. American Insulated Wire Corp.
 - b. Leviton Manufacturing Co.
 - c. Carol Cable Co., Inc.
 - d. Southwire Company.
 - e. Superior Essex (communications)
 - 2. Connectors for Wires and Cables:
 - a. AMP Incorporated.
 - b. General Signal; O-Z/Gedney Unit.
 - c. Monogram Co.; AFC.
 - d. Square D Co.; Anderson.
 - e. 3M Company; Electrical Products Division.
 - f. Leviton (communications)

2.2 BUILDING WIRES AND CABLES

- A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Wire and Insulation Applications" Article.
- B. Rubber Insulation Material: Comply with NEMA WC 3.
- C. Thermoplastic Insulation Material: Comply with NEMA WC 5.
- D. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
- E. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
- F. Conductor Material: Copper.
- G. Stranding: Solid conductor for No. 12 AWG and smaller; stranded conductor for larger than No. 12 AWG.
- H. Portable Cord: UL listed, sunlight, water, and weather resistant cord with oil-resistant thermoset jacket. 600V rated. See plans for conductor quantities per cable. Designed for hard usage with portable tools, small motors and power extensions. Suitable for outdoor applications.
- I. Telephone and data low voltage circuits: Category 6, plenum rated, unshielded twisted pair (UTP) or shielded twisted pair cable (see plans) in low smoke, flame retardant PVC outer jacket. All products herein must be Category 6 compliant and shall be installed following manufacturers' recommendations for installation and application.
- J. Telecommunications patch cords: All patch cords shall be factory assembled patch cords with factory made ends. All patch cords shall meet the performance characteristics of the telephone and data low voltage circuits described herein. The quantity of patch cords shall be per the plans. Patch cord length shall be equal to the minimum factory produced length that will allow cross connection and interconnection to be accomplished by the Agency without hindrance while allowing minimum bend radius, adequate strain relief, and proper cable management to be maintained at all times.

2.3 CONNECTORS AND SPLICES

- A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.
- B. Telephone and data communications cable connectors: Category 6 rated connectors that comply with all TIA/EIA-568-8 requirements. Assorted colors. Provide models and colors for connectors as specified in plans.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRE AND INSULATION APPLICATIONS

- A. Service Entrance: Type RHW or XHHW, in raceway.
- B. Exterior and underground: Type RHW or XHHW, in raceway.
- C. Feeders: Type THWN, in raceway.
- D. Branch Circuits: Type THWN, in raceway.
- E. Class 1 Control Circuits: Type THWN, in raceway.
- F. Class 2 Control Circuits: Type THWN, in raceway.
- G. Telephone and data low voltage circuits: Category 6, plenum rated, unshielded twisted pair (UTP) cable in low smoke, flame retardant PVC outer jacket, in raceway.
- H. Additional cables shall be provided as specified on the drawings.

3.3 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation." All conductors and cables shall be continuous from source to the device they feed. There shall be no splices in the conductor or cable unless shown otherwise. Do not exceed the bending radius of any conductor or cable, replace the conductors and or cables whose bending radius has been exceeded. Do not bend large feeders past their bending radius to install them in the feeder circuit breaker. If you do, replace the entire feeder.
- B. Remove existing wires from raceway before pulling in new wires and cables.
- C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Support cables according to Division 16 Section 16050 - Basic Electrical Materials And Methods. Any cable that has a vertical drop exceeding six feet shall be supported by a stainless steel cable grip.

- F. Identify wires and cables according to Division 16 Section 16050 - Basic Electrical Materials And Methods.
- I. All telecommunications cabling shall be run continuous from the specified work area jacks at the peripheral (drop) end to the specified patch panel. In accordance with the ANSI/TIA/EIA-568-A-5 standard, no UTP run shall exceed ninety (90) meters in length from the specified jack on the peripheral end to the specified patch panel. A minimum of 5' of slack shall be left loosely wound (1'-2' diameter) above each specified work area jack to facilitate future termination changes. Coil the cable above the suspended ceiling on a j-hook, before cable enters conduit in wall.
- J. All telecommunications installed cables, jacks, and connectors will be clearly labeled and documented to identify each cable connection. Each jack in each wall plate shall have a unique identifier that matches identifiers at the patch panel. Wall mounted jacks shall utilize a neat, long lasting computer generated stick-on label such as those printed on the Brady XC plus printer system. Computer generated tags shall be installed on all of the cables serving the work area in order to provide ready identification of all cables in the event that the surface markings are lost or mutilated. The labeling scheme shall be per the owner's requirements. Coordinate with LAA IT dept and obtain labeling numbering scheme before starting project. Provide numbering scheme on a set of floor plans with all devices shown and on elevation drawings showing the patch panels with appropriate numbering at each jack in panel. Provide these shop drawings prior to ordering materials.
- K. Run all cabling parallel and perpendicular to all walls, floors, and ceilings. When bringing cabling into equipment racks or onto mounting boards, train cables in groups, routing it parallel and perpendicular to equipment racks and mounting boards. Use cable management equipment to bundle all cables. There shall be no loose or dangling cables. Use cable ties every 12 inches to bundle cables where it is not possible to use cable management equipment.

3.4 CONNECTIONS

- A. Conductor Splices: No splices in feeders. No splices in branch circuits except at device locations. In underground circuits, the only splices shall be in the electrical enclosures on the light poles or in the electrical service equipment, panels, or wall/post mounted enclosures. Do not splice in exterior in ground junction boxes. If this happens, the conductors shall be replaced and the splices made in a light pole or service equipment, panel, or above ground enclosures.
- B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- C. Use splice and tap connectors compatible with conductor material.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.
- E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection.
- B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.
- C. Telephone and data communications cable testing: All UTP cabling will be certified to meet and or exceed the Category 6 specifications as set forth in TIA/EIA-568-B.1 Section 11, using a level II-E field tester pre-approved by the Agency's contract administrator. Certifications shall include the following parameters for each pair of each cable installed:
 - 1. Wire map (pin to pin connectivity)
 - 2. Length (in feet)
 - 3. Attenuation
 - 4. Near End Crosstalk (NEXT)
 - 5. Far End Crosstalk (FEXT)
 - 6. ELFEXT
 - 7. Attenuation/Crosstalk Ratio (ACR)
 - 8. Return Loss
 - 9. Propagation Delay
 - 10. Delay Skew
 - 11. Test equipment shall provide an electronic and printed record of these tests.

Owner reserves the right to hire an independent testing company to spot check the test results. If the results vary more than 10% from the results provided by the Contractor, the Contractor will be required to prove his results are correct or retest the entire system.

END OF SECTION 16120

SECTION 16130 – RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1. Raceways include the following:

- a. RMC.
- b. IMC.
- c. EMT.
- d. FMC.
- e. LFNC.
- f. RNC.

2. Boxes, enclosures, and cabinets include the following:

- a. Device boxes.
- b. Outlet boxes.
- c. Pull and junction boxes.
- d. Cabinets and hinged-cover enclosures.

- B. Related Sections include the following:

- 1. Division 16 Section 16050 - Basic Electrical Materials And Methods for raceways and box supports.
- 2. Division 16 Section 16140 – Wiring Devices for devices installed in boxes and for floor-box service fittings.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFNC: Liquidtight flexible nonmetallic conduit.
- E. RMC: Rigid metal conduit.
- F. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

- A. Product Data: For raceways and fittings, boxes, hinged-cover enclosures, and cabinets. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NECA's "Standard of Installation."
- C. Comply with NFPA 70.
- D. Comply with ANSI/ TIA/ EIA 568A - Commercial Building Telecommunications Cabling Standard, and ANSI/ TIA/ EIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces

1.5 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

1.6 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Metal Conduit and Tubing:

- a. Carol Cable Co., Inc.
 - b. Grinnell Co.; Allied Tube and Conduit Div.
 - c. Monogram Co.; AFC.
 - d. Triangle PWC, Inc.
- 2. Nonmetallic Conduit and Tubing:
 - a. Duraline.
 - b. STI Firestopper
- 3. Conduit Bodies and Fittings:
 - a. American Electric; Construction Materials Group.
 - b. Crouse-Hinds; Div. of Cooper Industries.
 - c. Emerson Electric Co.; Appleton Electric Co.
 - d. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - e. Lamson & Sessions; Carlon Electrical Products.
 - f. O-Z/Gedney; Unit of General Signal.
 - g. ETCO Speciality Products, Inc.
- 4. Boxes, Enclosures, and Cabinets:
 - a. Butler Manufacturing Co.; Walker Division.
 - b. Crouse-Hinds; Div. of Cooper Industries.
 - c. Hoffman Engineering Co.; Federal-Hoffman, Inc.
 - d. O-Z/Gedney; Unit of General Signal.
 - e. Robroy Industries, Inc.; Electrical Division.
 - f. Thomas & Betts Corp.
- 5. Cable Hook Systems:
 - a. Cooper B-Line
 - b. Other

2.2 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1. Use only malleable iron conduit bodies, no aluminum conduit bodies.
- B. IMC: ANSI C80.6.
- C. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Set-screw or compression type.
- D. FMC: Zinc-coated steel.
- E. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

- A. RNC: Schedule 40 PVC per NEMA TC 2 or HDPE Conduit per ASTM D2447-95. The HDPE conduit shall have a wall thickness of at least 0.154 inches + 0.020 inches. The conduit shall be cooled to room temperature after manufacture and prior to being rolled on a spool. Provide a conduit straightening mechanism to remove the “reel memory” from the conduit prior to installation. Instead of using a conduit straightening mechanism, the conduit shall be spooled out on the ground and allowed to “relax” for at least 24 hours prior to being placed in the trench. If the conduit still has peaks and valleys, it shall be straightened.
- B. RNC Fittings: Double E-Loc Couplings. The couplings shall be friction-fit, water-tight with an elastomeric seal inside a Schedule 80 PVC shell. The seal shall be grooved to enhance the friction fit. The couplings shall have a gripper ring and lock nut on each end. The couplings shall provide an air tight, water tight splice. All other fittings for HDPE conduit such as elbows, threaded connectors and adapters to flexible conduit, etc. shall be rigid steel conduit. Transitions from HDPE to rigid steel conduit fittings shall be performed using rigid steel conduit and Double E-Loc couplings. Provide Double E-Loc couplings by ETCO Speciality Products, Inc. or an approved equal. Use rigid steel elbows when using PVC conduit.
- C. Fire-rated pathway fittings: UL Listed for use in rated fire walls of ratings and construction as specified in the architectural plans. See architectural plans for locations of fire rated walls. Provide material data sheet in submittal package. Pathway shall be tested and approved for cable capacities range from 0 to 100% visual fill. The fire-rated pathway shall contain a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The seal-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall the firestop materials.

2.4 OUTLET AND DEVICE BOXES

- A. Sheet Metal Boxes: NEMA OS 1.
- B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.
- C. Nonmetallic Boxes: NEMA OS 2.

2.5 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS 1.
- B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- C. All boxes installed outside of the building interior shall be hot-dipped galvanized cast steel boxes or stainless steel boxes.

2.6 ENCLOSURES AND CABINETS

- A. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

- B. Cabinets: Inside building. NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.
- C. Exterior: NEMA 4X. All enclosures and cabinets mounted outside the building interior shall be NEMA 4X type 316L stainless steel.

2.7 CABLE HOOK SYSTEMS

- A. Cable hooks shall have a flat bottom and provide a minimum of 1-5/8 inch cable bearing surface.
- B. Cable hooks shall have 90-degree radiused edges to prevent damage while installing cables.
- C. Cable hooks shall be designed so the mounting hardware is recessed to prevent cable damage.
- D. Cable hooks shall have a stainless steel cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.
- E. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet project site conditions.
- F. Factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed.
- G. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653.
- H. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

- A. Outdoors: Use the following wiring methods:
 - 1. Exposed: Rigid steel.

2. Concealed: Rigid steel.
3. Underground, Single Run: RNC or Rigid Steel.
4. Underground, Grouped: RNC or Rigid Steel
5. Underground, spare conduit: Rigid Steel.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
7. Boxes and Enclosures: NEMA 4X, unless noted otherwise.
8. Under concrete slab: RNC or Rigid Steel.

B. Indoors: Use the following wiring methods:

1. Exposed: EMT or IMC.
2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFNC.
3. Damp or Wet Locations: Rigid steel conduit.
4. Classified locations: Rigid steel conduit. For Class 1, Div. 2 locations, this includes the portion of the conduit run between the conduit seal off and where the conduit leaves the classified location. For Class 1, Div. 1, conduit runs that terminate outside of the classified area have to be rigid steel.
5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel or hot-dipped galvanized steel.
 - b. Classified areas: Explosion proof boxes, malleable iron or cast steel, hot dipped galvanized.

3.3 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Minimum Raceway Size: 1/2-inch trade size (DN16).
- C. All conduit may be surface mounted.
- D. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- E. Install raceways level and square and at proper elevations. Provide adequate headroom.
- F. Complete raceway installation before starting conductor installation.
- G. Support raceways as specified in Division 16 Section 16050 Basic Electrical Material And Methods.
- H. Use temporary closures to prevent foreign matter from entering raceways.
- I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

- J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- K. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
- L. Raceways under Slabs: Do not install conduit in the slab. Conduit may be installed under the slab. This is preferable to installing it in the walls. Install all home runs from the panel, TTB, and Computer Network Equipment Rack under the slab if practical. This shall be done so that additional wiring can be easily pulled in the future.
 - 1. Locate conduit at least 4 inches below slab. Cover conduit with pit run, D-1, sand, or pea gravel.
 - 2. Locate the conduit 2 inches apart laterally and 2 inches apart vertically under the slab.
 - 3. Run conduit parallel and perpendicular to the stem walls.
 - 4. Transition from nonmetallic tubing to rigid steel conduit before rising above floor. All transitions through the concrete shall be rigid steel conduit up to 24" AFF. Transitions through the slab in classified areas shall be continuous with no fittings, couplings, unions until the conduit seal off.
 - 5. Provide six inches min. clearance from the radiant heat tubing and other mechanical and structural equipment.
- M. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
 - 1. Run parallel or banked raceways together, on common supports where practical.
 - 2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- N. Join raceways with fittings designed and approved for the purpose and make joints tight.
 - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - 2. Use insulating bushings to protect conductors.
- O. Tighten set screws of threadless fittings with suitable tools.
- P. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
- Q. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

- R. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- S. Telephone and Signal System Raceways, 2-Inch Trade Size (DN53) and Smaller: In addition to the above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- T. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- U. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 24 inches (150 mm) above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
- V. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

3.4 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

3.5 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 16130

SECTION 16140 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes receptacles, connectors, switches, and finish plates.

1.2 SUBMITTALS

A. Product Data: For each product specified.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with NEMA WD 1.
- C. Comply with NFPA 70.

1.4 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the WORK include, but are not limited to, the following:
 - 1. Wiring Devices:
 - a. Bryant Electric, Inc.
 - b. GE Company; GE Wiring Devices.
 - c. Hubbell, Inc.; Wiring Devices Div.
 - d. Leviton Manufacturing Co., Inc.

- e. Pass & Seymour/Legrand; Wiring Devices Div.

2.2 RECEPTACLES

- A. Straight-Blade and Locking Receptacles: Industrial Specification grade. 120 volt, 20 amp rated, min. Ivory

2.3 SWITCHES

- A. Snap Switches: Heavy-duty, quiet type. Industrial Specification grade 120 volt, 20 amp rated, min. Ivory

2.4 WALL PLATES

- A. Single and combination types match corresponding wiring devices.
 - 1. Material for mechanical rooms: Galvanized steel.
 - 2. Material for all other spaces: Stainless steel.
- B. Telephone and data receptacles.
 - 1. Category 6 modular jack devices, 8-position, 8-conductor modular jacks, terminated to 110 type IDC connections for the installation of UTP cable.
 - 2. Units shall be labeled in accordance with both wiring designations T568A/B, See details for cable connections and labeling.
 - 3. Provide and install faceplates for mounting telecommunication outlet connector modules described elsewhere in the specifications. Single-gang faceplate or double-gang faceplate, as required and as indicated on the plans.
 - 4. Provide and install blank inserts as needed.
 - 5. Label communication faceplates in accordance with both wiring designations T568A/B.
 - 6. Ivory.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies plumb and secure.
- B. Install wall plates when painting is complete.
- C. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- D. Protect devices and assemblies during painting.

3.2 IDENTIFICATION

- A. Comply with Division 16 Section 16050 – Basic Electrical Material And Methods.

1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
2. Receptacles: Identify panelboard and circuit number from which served. Engrave all cover plates with panel designation and circuit number feeding the receptacle.

3.3 CONNECTIONS

- A. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.
- B. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.
- B. Replace damaged or defective components.

3.5 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 16140

SECTION 16452 – GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 16 Section 16120 – Conductors And Cables.

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for grounding rods, connectors and connection materials, and grounding fittings.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with UL 467.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.4 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ideal Industries, Inc.
2. Burndy
3. O-Z/Gedney Co.
4. Thomas & Betts, Electrical.

2.2 GROUNDING AND BONDING PRODUCTS

- A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS

- A. Comply with Division 16 Section 16120 – Conductors And Cables. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

1. Material: copper. Use only copper wire.
- B. Equipment Grounding Conductors: Insulated with green color insulation.
- C. Grounding-Electrode Conductors: Stranded cable.
- D. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- E. Bare Copper Conductors: Conform to the following:
1. Solid Conductors: ASTM B 3.

2.4 MISCELLANEOUS CONDUCTORS

- A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.
- C. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, except as indicated.

2.5 CONNECTOR PRODUCTS

- A. Pressure Connectors: High-conductivity-plated units.

- B. Bolted Clamps: Heavy-duty type.
- C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.6 GROUNDING ELECTRODES AND TEST WELLS

- A. Grounding Rods: Sectional type; copper-clad steel.
 - 1. Size: 3/4 inch by 120 inches (19 by 3000 mm).

PART 3 - EXECUTION

3.1 APPLICATION

- A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
 - 1. Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:
 - a. Feeders and branch circuits.
 - b. Lighting circuits.
 - c. Receptacle circuits.
 - d. Single-phase motor or appliance branch circuits.
 - e. Three-phase motor or appliance branch circuits.
 - f. Flexible raceway runs.
 - g. Armored and metal-clad cable runs.
 - h. All circuits in conduit including low voltage.
 - 2. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- B. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide a No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, terminal cabinet, wiring closet (telephone terminal board), racks, cabinets, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
 - 1. Other System Requirements: Furnish ground terminal block for each rack and cabinet section. Rack shall be grounded using #6 AWG stranded, insulated copper conductor. Furnish all required bonding material (racks and runway) and hardware.

Refer to ANSI/TIA/EIA-607-1994, Commercial Building Grounding and Bonding Requirements for Telecommunications, for details.

- C. Separately Derived Systems: Where NEC requires grounding, ground according to NEC Paragraph 250-26.

3.2 INSTALLATION

- A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
- B. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.
 - 1. Drive until tops are 2 inches (50 mm) below finished floor or final grade, except as otherwise indicated.
 - 2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.
- C. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.
- E. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.
- F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.
- G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- H. Bond to the frame of the metal building. Bond to rebar in the building foundation.

3.3 CONNECTIONS

- A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor. Use compression connections for all connections to re-bar. Connection to ground rods may be compression or exothermic welded connection.
- G. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 FIELD QUALITY CONTROL

- A. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method according to IEEE 81.

- B. Maximum grounding to resistance values are as follows:
 - 1. Equipment Rated 500 kVA and Less: 10 ohms.
- C. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to accomplish recommended work.
- D. Report: Prepare test reports of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.5 ADJUSTING AND CLEANING

- A. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 16452

SECTION 16470 – PANELBOARDS AND SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less. Also included is the main switchboard.
- B. Related Sections include the following:
 - 1. Division 16 SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS for general materials, installation, and labeling methods.

1.2 SUBMITTALS

- A. Product Data: For each type of panelboard, switchboard, accessory item, and component specified. Provide shop drawings for the switchboard showing each section and what it contains.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- C. Maintenance Data: For panelboard and switchboard components to include in the maintenance manuals specified in Division 1. Include manufacturer's written instructions for testing circuit breakers.

1.3 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- C. Comply with NFPA 70.
- D. Comply with NEMA PB 1.

1.4 EXTRA MATERIALS

- A.Keys: 6 spares of each type for panelboard cabinet lock.

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Corp.; Westinghouse & Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Control Div.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D Co.

2.2 PANELBOARD AND SWITCHBOARD FABRICATION

- A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise indicated to meet environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 4X stainless steel.
 - 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
- B. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.
- C. Directory Frame: Metal, mounted inside each panelboard door.
- D. Bus: Hard drawn copper of 98 percent conductivity.
- E. Main and Neutral Lugs: Compression type.
- F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.
- G. Service Equipment Approval: Listed for use as service equipment for MDP panelboard.

- H. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.
- I. The switch board shall be listed as an assembly with separate sections for each function as shown on the plans. The switchboard shall be a stand alone, self-supporting unit. The bus bar shall run throughout the unit behind a dead front.

2.3 BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.
- C. The panelboard shall have a series rating with the circuit breaker that feeds it of 65,000 AIC or as shown on the drawings.

2.4 DISTRIBUTION PANELBOARDS

- A. Doors: In panelboard front, except omit in fusible-switch panelboard, unless otherwise indicated. Secure door with vault-type latch with tumbler lock, all keyed alike.
- B. Branch-Circuit Breakers: Provide a bus with "I-line style" circuit breakers that grasp the bus and are bolted in place. Provisions and other mounting equipment shall not be required to add a circuit breaker. Provide with circuit breaker mounting space shown on the drawings.
- C. The panelboard shall have a series rating with the main circuit breaker in the switchboard of 65,000 AIC or as shown on the drawings.

2.5 SWITCHBOARD

- A. The switchboard shall have three sections with an overall rating as shown on the drawings. The first section shall contain the main terminal lugs to receive the service lateral conductors. These lugs shall be connected to a CT mounting base of the same rating as the switchboard. The CT base shall be designed for bar type CTs. Coordinate with the local utility to provide a CT section that meets their requirements. Provide a remote meter base in a NEMA 1 enclosure to be mounted next to the utility transformer and fed from the CTs. The CT mounting base shall be bolted to the switchboard bus bar. The main terminations shall be located behind a bolted panel. The CTs shall be located behind a panel that is hinged on one side and bolted on the other. The switchboard shall have an AIC rating of 65,000.
- B. The second switchboard section shall hold the main circuit breaker. The main circuit breaker shall connect to the bus bar on both sides and shall have the ratings shown on the drawings. The main circuit breaker section shall have a dead front around the circuit breaker with handle and overcurrent adjustment accessible. The main circuit breaker shall have a shunt trip mechanism with a remote operator as shown on the drawings. It shall also have a ground fault interrupter mechanism.

- C. The third switchboard section shall hold the main distribution panel. The panel shall be a Square D I-Line style with two columns of circuit breakers; one on each side with the main bus work down the center. The circuit breakers shall slide onto and grasp the bus work on one end and shall be bolted into place. Provide blank covers for all unused spaces. There shall be no provisions required to mount a circuit breaker or to provide spare capacity for a future circuit breaker. Provide the amount of circuit breaker mounting space shown on the drawings. The switchboard shall have dead front covers over the feeder wiring terminations on the circuit breakers. These covers shall be hinged on one side and bolted on the other for easy access of the circuit breaker terminations.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
 - 1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current. The circuit breaker shall have the AIC rating required for the panel/switchboard it is mounted in.
 - 2. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
 - 4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings. The main circuit breaker shall be rated at 1600 amps and shall be field adjustable down to 1200 amps.
 - 5. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
 - 6. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
 - 7. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
 - 8. Shunt Trip: Where indicated.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and switchboard and accessory items according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

- D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.
- E. Install filler plates in unused spaces.
- F. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.
- G. Neatly train wiring in switchboard. Bend conductors per their manufacturer's recommendations and listing requirements. Feeder conductors that are bent at a hard ninety degree angle shall be replaced.

3.2 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 16 SECTION 16050 – BASIC ELECTRICAL MATERIALS AND METHODS.
- B. Nameplates: Label each panelboard and switchboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

3.3 GROUNDING

- A. Make equipment grounding connections for panelboards as indicated.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
 - 2. Make continuity tests of each circuit.
- B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

3.6 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

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3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION 16470

SECTION 16476 – DISCONNECT SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes individually mounted switches and circuit breakers used for the following:
 - 1. Service disconnect switches.
 - 2. Feeder and equipment disconnect switches.
 - 3. Feeder branch-circuit protection.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 16 Section 16140 - Wiring Devices for attachment plugs and receptacles, and snap switches used for disconnect switches.

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for disconnect switches, circuit breakers, and accessories specified in this Section.
- C. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.
- B. Comply with NFPA 70 for components and installation.
- C. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.4 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final

verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.

- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.

1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering disconnect switches and circuit breakers that may be incorporated into the Work include, but are not limited to, the following:

1. Molded-Case Circuit Breakers:
- a. American Circuit Breaker Corp.
 - b. Eaton Corp.; Cutler-Hammer Products.
 - c. General Electric Co.; Electrical Distribution and Control Division.
 - d. Klockner-Moeller.
 - e. Siemens Energy & Automation, Inc.
 - f. Square D Co.
 - g. Westinghouse Electric Corp.; Distribution & Control Business Unit.

2.2 DISCONNECT SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type Heavy Duty (HD), with lockable handle rated at 600V.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position. Provide with dual element, time delay class RK1 fuses; Bus LowPeak or equal.
- C. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
- 1. Outdoor Locations: Type 4X, Stainless Steel, 316L.
 - 2. Other Wet or Damp Indoor Locations: Type 4X, Stainless Steel.

2.3 ENCLOSED CIRCUIT BREAKERS

- A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.
- B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current. See Single Line Diagram for required fault current rating. Meet rating of device feeding circuit breaker.

- C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.
- D. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
- E. Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous-current settings.
- F. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
- G. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
- H. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.
- I. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
- J. Shunt Trip: Where indicated.
- K. Accessories: As indicated.
- L. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
 - 1. Outdoor Locations: Type 4X, 316L Stainless steel.
 - 2. Other Wet or Damp Indoor Locations: Type 4X 316L Stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
- B. Install disconnect switches and circuit breakers level and plumb.
- C. Install wiring between disconnect switches, circuit breakers, control, and indication devices.
- D. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- E. Identify each disconnect switch and circuit breaker according to requirements specified in Division 16 Section 16050 - Basic Electrical Materials And Methods.

3.2 FIELD QUALITY CONTROL

- A. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
- B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 ADJUSTING

- A. Set field-adjustable disconnect switches and circuit-breaker trip ranges as indicated.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 16476

SECTION 16478 – TRANSIENT VOLTAGE SUPPRESSION

PART 1- GENERAL

1.1 SUMMARY

- A. This Section includes transient voltage surge suppressors for low-voltage (600V or less) circuits and equipment.

1.2 SYSTEM DESCRIPTION

- A. Transient voltage suppression for low-voltage distribution systems, with suppressors located at each major bus, including service entrances, feeders, and branch-circuit distribution equipment.
- B. System Exposure: IEEE C62.41, medium.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Maintenance Data: For transient voltage surge suppressors to include in the maintenance manuals specified in Division 1.
- D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide electrically operated equipment specified in this Section that is listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NFPA 70.

1.5 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the OWNER of other rights the OWNER may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the CONTRACTOR under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, executed by manufacturer, agreeing to repair or

replace components of transient voltage surge suppressors that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: 3 years from date of Substantial Completion.

1.6 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 1. Section 01810: Testing, Commissioning, and Training

PART 2- PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Liebert, Inc.
 2. Transtector Systems, Inc.
 3. Leviton, Inc.
 4. Square D Co.

2.2 TRANSIENT VOLTAGE SURGE SUPPRESSORS

- A. Functional Description: Solid-state, 2-stage, transient voltage surge suppressors employing no series-connected suppression components.
 1. Primary Suppression: Employs metal oxide varistor suppression modules or silicon avalanched diode suppression modules.
 2. Secondary Suppression: Employs metal oxide varistor suppression modules.
 3. Fuses in each suppression-module circuit prevent damage to suppressor during failure of any module.
- B. Overall Ratings: As indicated and as required to comply with location categories according to NEMA LS 1.
- C. Maximum Continuous Operating Voltage: At least 115 percent of nominal system operating voltage.
- D. Connection Means: Permanently wired.
- E. Protection Modes: Include the following:

1. Line-to-neutral.
2. Line-to-line.
3. Line-to-ground.
4. Neutral-to-ground.

F. Service Conditions: Include the following:

1. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
2. Humidity: 0 to 85 percent, non-condensing.
3. Altitude: Less than 20,000 feet (6000 m) above sea level.

G. Enclosure: NEMA 250, Type 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with requirements for installation tolerances, power characteristics, and other conditions affecting performance of transient voltage surge suppressors. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 CONNECTIONS

- A. Connect transient voltage suppression circuit in line-to-neutral configuration if a neutral conductor is available.
- B. Ground each transient voltage surge suppressor enclosure.
1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Supervision of the field assembly of components and installation of transient voltage surge suppressors, including electrical connections, by a factory-authorized service representative. Report results in writing.

END OF SECTION 16478

SECTION 16481 – MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ac motor-control devices rated 600 V and less that are supplied as enclosed units.
- B. Related Sections include the following:
 - 1. Division 16 Section "Basic Electrical Materials and Methods" for general materials and installation methods.

1.2 SUBMITTALS

- A. Product Data: For products specified in this Section. Include dimensions, ratings, and data on features and components.
- B. Maintenance Data: For products to include in the maintenance manuals specified in Division 1.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain similar motor-control devices through one source from a single manufacturer.
- B. Comply with NFPA 70.
- C. Listing and Labeling: Provide motor controllers specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

1.4 COORDINATION

- A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, and the duty cycle of the motor and load.

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
 - 2. Allen-Bradley Co.; Industrial Control Group.
 - 3. Crouse-Hinds ECM.; Cooper Industries, Inc. Div.
 - 4. Danfoss Inc.; Danfoss Electronic Drives Div.
 - 5. Eaton Corp.; Westinghouse & Cutler-Hammer Products.
 - 6. Furnas Electric Co.
 - 7. General Electric Co.; Electrical Distribution & Control Div.
 - 8. Siemens Energy & Automation, Inc.
 - 9. Square D Co.

2.2 MAGNETIC MOTOR CONTROLLERS

- A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
- B. Control Circuit: 120 V; obtained from integral control power transformer, unless otherwise indicated. Include a control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
- C. Overload Relay: Digital Solid State Motor Overload Relay Provide with sensors in each phase matched to nameplate full-load current of specific motor to which they connect, and with appropriate adjustment for duty cycle. Provide Class 20 overload protection or appropriate class as recommended by equipment manufacturer.

2.3 ENCLOSURES

- A. Description: Flush or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to meet environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 4X, Stainless Steel.
2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X, Stainless Steel.

2.4 COMBINATION STARTER DISCONNECT

- A. Provide heavy duty fused disconnect and NEMA magnetic motor controller in one UL listed unit.
- B. Provide size as shown on the drawings. Provide with fusing appropriately sized to motor. Provide overload relay size as required for motor.
- C. Provide with integral HOA switch and a minimum of two dry normally open auxillary contacts that close with the starter coil.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.
- C. Provide starters as shown on the drawings.
- D. All magnetic starters shall be combination starters/disconnects.

3.2 INSTALLATION

- A. Install as shown on the drawings.

3.3 IDENTIFICATION

- A. Identify motor-control components and control wiring according to Division 16 Section 16050 Basic Electrical Materials and Methods.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between motor-control devices according to Division 16 Section 16120 Conductors and Cables.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic control devices where available.
 1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.

2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

- A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

- A. Testing: After installing motor controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.
 2. Remove and replace malfunctioning units with new units, and retest.

3.7 CLEANING

- A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

END OF SECTION 16481

SECTION 16490 - MOTORS

PART - GENERAL

1.1 SUMMARY

- A. This Section includes ac motors rated 600 V and less.
- B. Related Sections include the following:
 - 1. Division 16 Section 16195 "Basic Electrical Materials and Methods" for labeling materials.
 - 2. Division 16 Section 16481 "Motor Controllers" for motor starters
 - 3. Division 15.

1.2 SUBMITTALS

- A. Product Data: For products specified in this Section. Include dimensions, ratings, and data on features and components.
- B. Maintenance Data: For products to include in the maintenance manuals specified in Division 1, Section 01730 "Maintenance and Operations".

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain similar motors through one source from a single manufacturer.
- B. Comply with NFPA 70.
- C. Listing and Labeling: Provide motors specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

1.4 COORDINATION

- A. Coordinate features, accessories, and functions of each motor with the ratings and characteristics of the supply circuit, the motor controller, the required control sequence, and the required duty cycle of the load.

1.5 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required

to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.

- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.

- 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide motors conforming to NEMA standards. The frame size, enclosures, etc., shall be suited to the application.
- B. A label shall be attached to the motor noting the motor ratings.
- C. Determine the supply voltage from the drawings. Provide motors capable of operating at rated load at plus or minus 10 percent of the supply voltage.
- D. Provide motors as an integral part of their associated equipment and systems. Coordinate with the other Specification Divisions as required.
- E. Provide motors manufactured for use with variable frequency drives, and solid state starters and compliant with NEMA MG1 PART 31.
- F. Provide motors with a corona inception voltage of 5,500 volts min.

2.2 SERVICE FACTOR

- A. Provide motors with a service factor of 1.15 min.
- B. Certify motors with intermittent and/or varying duty cycles and loads for their specific applications.
- C. Size the motor such that it's rating is never exceeded.

2.3 INSULATION

- A. Provide motors with NEMA Class F insulation and Class H varnish, unless otherwise noted.
- B. The motors greater than 1 horsepower shall have a NEMA Class B temperature rise, based upon ambient temperature of 40 degrees Celsius.

2.4 LOCKED ROTOR CURRENT

- A. Provide motors less than 15 horsepower with locked rotor current rating less than NEC code M, per NEC Table 430-7(b).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install the motor as required by the application and in accordance to the manufacturer's requirements.
- B. Ensure proper alignment and dynamic balancing.
- C. Verify proper rotational direction.
- D. Install the motorized equipment ensuring minimal transmission of vibration. Utilize anti-vibration pads and inertial dampeners as required.
- E. Connect conductors and raceways allowing for minimal vibration transmission, as required.
- F. The drawings indicate motor sizes based upon certain manufacturers' information. Adjust sizes of conductors, raceways, motor controllers, variable speed drives, chokes, filters, over-current protection, etc. as necessitated by motor size changes.

3.2 IDENTIFICATION

- A. Identify motors and control wiring according to Division 16 Section 16050 "Basic Electrical Materials and Methods".

3.3 CONNECTIONS

- A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

END OF SECTION 16490

SECTION 16511 – INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, and accessories.

1.2 SUBMITTALS

- A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:
 - 1. Dimensions of fixtures.
 - 2. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data.
 - 3. Certified results of laboratory tests for fixtures and lamps for photometric performance.
 - 4. Emergency lighting unit battery and charger.
 - 5. Fluorescent and high-intensity-discharge ballasts.
 - 6. Air and Thermal Performance Data: For air-handling fixtures. Furnish data required in "Submittals" Article in Division 15 Section "Diffusers, Registers, and Grilles."
 - 7. Sound Performance Data: For air-handling fixtures. Indicate sound power level and sound transmission class in test reports certified according to ADC.
 - 8. Types of lamps.

1.3 QUALITY ASSURANCE

- A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with NFPA 70.
- C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

1.4 COORDINATION

- A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

1.5 WARRANTY

- A. General Warranty: The warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Replace all luminaires, or associated equipment that fails to operate properly within one year from date of final completion.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed (10%). Furnish at least two of each type.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Reflectors, Glare Shields, Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products indicated in the Interior Lighting Fixture Schedule at the end of Part 3.
- B. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Interior Lighting Fixture Schedule at the end of Part 3.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
 - 1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
 - 2. Lens Thickness: 0.125 inch (3 mm) minimum, unless greater thickness is indicated.
- F. Electromagnetic Interference Filters: Integral to fixture assembly. Provide one filter for each ballast. Suppress conducted electromagnetic interference filters as required by MIL-STD-461.

2.3 FLUORESCENT LAMP BALLASTS

- A. General Requirements: Unless otherwise indicated, features include the following:
 - 1. Designed for type and quantity of lamps indicated at full light output.
 - 2. Total Harmonic Distortion Rating: Less than 20 percent.
- B. Electronic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:
 - 1. Certified Ballast Manufacturer Certification: Indicated by label.
 - 2. Encapsulation: Without voids in potting compound.
 - 3. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.

2.4 HIGH INTENSITY DISCHARGE BALLASTS

- A. Comply with ANSI C82.4. Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.
 - 1. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
 - 2. Single-Lamp Ballasts: Minimum starting temperature of minus 40 deg C.
 - 3. Open-circuit operation will not reduce average life.

4. High-Pressure Sodium Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 deg C.
5. Noise: Uniformly quiet operation, with a noise rating of B or better.
6. Surge Protector: Hard-wired unit external to ballast case, rated for supply circuit line voltage, and encapsulated for circuit and moisture protection. Three-stage surge protection with three suppression modes provides 330-V peak clamping, line to neutral, line to ground, and neutral to ground. Pulse life is 500 3KA-8x20 microsecond impulses, and response time is less than 1 nanosecond. Internal fuse takes device off line on failure and lights a light-emitting diode failure indicator.

2.5 LAMPS

- A. Fluorescent Color Temperature and Minimum Color-Rendering Index: 3500 K and 85 CRI, unless otherwise indicated.

2.6 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 16 Section 16050 Basic Electrical Materials and Methods, for channel- and angle-iron supports and nonmetallic channel and angle supports.

2.7 FINISHES

- A. Fixtures: Manufacturer's standard, unless otherwise indicated.
 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 2. Metallic Finish: Corrosion resistant.

2.8 ADDITIONAL REQUIREMENTS

- A. As stated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.
- B. Provide electronic ballasts on all fluorescent luminaries.

3.2 CONNECTIONS

- A. Ground equipment.
 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Provide instruments to make and record test results.
- C. Tests: As follows:
 - 1. Verify normal operation of each fixture after installation.
 - 2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
 - 3. Verify normal transfer to battery source and retransfer to normal.
 - 4. Report results in writing.
- D. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- E. Corrosive Fixtures: Replace during warranty period.

3.4 CLEANING AND ADJUSTING

- A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

END OF SECTION 16511

SECTION 16521 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories.

1.2 DEFINITIONS

- A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including post, foundation, or other structure, and mounting and support accessories.
- B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.3 SUBMITTALS

- A. Product Data: For each type of lighting unit indicated, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Materials and dimensions of luminaires.
 - 2. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data.
 - 3. High-intensity-discharge luminaire ballasts.
 - 4. Provide information on the candela output along the vertical axis for each luminaire to show compliance with the requirements on the drawings.
- B. Product Certificates: Signed by manufacturers of lighting units certifying that products comply with requirements.
- C. Maintenance Data: For lighting units to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Luminaires and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.
- D. FM Compliance: Units for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

1.5 DELIVERY, STORAGE, AND HANDLING OF POLES

- A. Store luminaires in warm, dry, and heated space, protected from damage, prior to installation.

1.6 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive OWNER of other rights OWNER may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under requirements of the Contract Documents. Provide a general warranty for all materials and workmanship for a period of three years from the date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least two of each type.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Reflectors, Glare Shields, Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products indicated on the drawings.

2.2 LUMINAIRES

- A. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- B. Metal Parts: Free from burrs, sharp corners, and edges.
- C. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Housings: Stainless Steel. Weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- E. Doors, Frames, and Other Internal Access: Stainless Steel. Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.
- F. Exposed Hardware Material: Stainless steel.
- G. Plastic Parts: No plastic parts.
- H. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- I. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.
- J. Photoelectric Relays: As follows:
 - 1. Contact Relays: Single throw, arranged to fail in the on position and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay.
 - 2. Relay Mounting: In electrical enclosures.
- K. High-Intensity-Discharge Ballasts: Comply with ANSI C82.4. Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.
 - 1. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
 - 2. Single-Lamp Ballasts: Minimum starting temperature of minus 40 deg C.
 - 3. Open-circuit operation will not reduce average life.
 - 4. High-Pressure Sodium Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 deg C.

5. Noise: Uniformly quiet operation, with a noise rating of B or better.
 6. Surge Protector: Hard-wired unit external to ballast case, rated for supply circuit line voltage, and encapsulated for circuit and moisture protection. Three-stage surge protection with three suppression modes provides 330-V peak clamping, line to neutral, line to ground, and neutral to ground. Pulse life is 500 3KA-8x20 microsecond impulses, and response time is less than 1 nanosecond. Internal fuse takes device off line on failure and lights a light-emitting diode failure indicator.
- L. Lamps: Comply with the standard of the ANSI C78 series that is applicable to each type of lamp. Provide luminaires with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a luminaire, provide medium wattage lamp recommended by manufacturer for luminaire.
1. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated.
- M. Additional Requirements: As shown on the drawings.

2.3 LUMINAIRE SUPPORT COMPONENTS

- A. Description: Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation. Wind loads shall be in accordance with UBC-1997.
- B. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping with a basic wind speed of 90 mph and with the application of the relevant height, exposure, gust factor, and pressure coefficients. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.
1. Strength Analysis: For each pole type and luminaire combination, 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.
- C. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.
- D. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Will not cause galvanic action at contact points.
 2. Mountings: Correctly position luminaire to provide indicated light distribution.
 3. Anchor Bolts, Nuts, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.
 4. Anchor-Bolt Template: Plywood or steel.

2.4 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Aluminum: Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 1. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 2. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 607.1.
 - 3. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 606.1 or AAMA 608.1.
 - a. Color: Light bronze.
 - b. Color: Medium bronze.
 - c. Color: Dark bronze.
 - d. Color: Black.
 - 4. Gold Anodic Finish: AA-M32C22A43 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, impregnated color coating 0.018 mm or thicker) complying with AAMA 611; gold color.
- C. Steel: Grind welds and polish surfaces to a smooth, even finish.
 - 1. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A 123.
 - 2. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 3. Interior: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Luminaire Attachment: Fasten to indicated structural supports.
- B. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.
- C. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 CONNECTIONS

- A. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Ground metal poles/support structures according to Division 16 Section 16452 – Grounding.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed unit for damage. Replace damaged units.
- B. Advance Notice: Give dates and times for field tests.
- C. Provide instruments to make and record test results.
- D. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source, and as follows:
 - 1. Measure light intensities at night if specific illumination performance is indicated. Use photometers with calibration referenced to NIST standards.
 - 2. Check intensity and uniformity of illumination.
 - 3. Check excessively noisy ballasts.
- E. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results.
- F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.4 CLEANING AND ADJUSTING

- A. Clean units after installation. Use methods and materials recommended by manufacturer.
- B. Adjust luminaires and luminaires with adjustable lamp position to provide required light distributions and intensities.

END OF SECTION 16521

SECTION 16611 – UNINTERRUPTIBLE POWER SUPPLY

PART 1- GENERAL

1.1 SUMMARY

- A. This Section includes 1.5 KVA UPS for indoor installation for support of solid-state electronics and computer-based systems in indoor locations in non-corrosive environments. The Section is for industrial-grade true on-line UPS that provide 100% isolation from incoming power using a full rectifier-inverter configuration.

1.2 SYSTEM DESCRIPTION

- A. Rack mounted UPS – The ups shall be rated at 1500VA at an input voltage of 120V with an output voltage of 120/240 Volts. The UPS shall be a true on-line UPS with double conversion system. It shall convert the incoming AC power to DC, store it in a battery, then convert the power back to AC for output. Provide (1) extended battery module (EBM) with the UPS. The UPS shall have the following features and performance specifications: Standard UPS system will include a minimum of (1) rectifier, (1) inverter, (1) static bypass, (1) maintenance bypass, and (1) battery system.

1.3 CODES & STANDARDS

- A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City and Borough of Juneau:
 - 1. National Electrical Code (NEC) NFPA 70

1.4 SUBMITTALS

- A. The CONTRACTOR shall submit sufficient information to indicate the scope and quality of the UPS system installation.
- B. System configuration with single-line diagrams.
- C. Functional relationship of equipment including weights, dimensions, and heat dissipation.
- D. Descriptions of equipment to be furnished, including deviations from these specifications. Size and weight of shipping units to be handled by CONTRACTOR.
- E. Detailed installation drawings including all terminal locations.
- F. Block diagram showing system relationships of major components and quantities and interconnecting cable requirements.
- G. Wiring diagrams showing terminal identification for factory, as well as field-installed, wiring.

H. Warranties: Special warranties specified in this Section.

I. Catalog literature.

1.5 OWNER'S MANUAL

A. The specified UPS system shall be supplied with OWNER'S MANUAL. The OWNER'S MANUAL shall include installation drawings and instructions, a functional description of the equipment with block diagrams, safety precautions, illustrations, step by step operating procedures, and routine maintenance guidelines.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the OWNER of other rights the OWNER may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the CONTRACTOR under requirements of the Contract Documents.

B. The UPS manufacturer shall warrant the UPS, including batteries, against defects in materials and workmanship for one (1) year.

C. Special Warranty: A written warranty, executed by manufacturer, agreeing to repair or replace components of transient voltage surge suppressors that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: 3 years from date of Substantial Completion.

D. All UPS, battery, and manufacturer's standard warranties shall be passed to the OWNER.

1.7 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The manufacturer of the UPS system shall be a reputable manufacturer regularly engaged in manufacturing and supporting UPS systems for industrial and commercial facilities.

B. The manufacturer shall be ISO9001 registered with a minimum of 20 years experience in the design, manufacture and testing of uninterruptible power supplies.

C. Factory Testing: Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specifications.

1.8 COORDINATION WITH COMMISSIONING

A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.

- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.

1. Section 01810: Testing, Commissioning, and Training

PART 2- PRODUCTS

2.1 GENERAL

- A. All materials and components making up the UPS system shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. The UPS shall be constructed of replaceable subassemblies. All active electronic devices shall be solid-state.

2.2 SYSTEM DESCRIPTION

- A. Modes of Operation: The UPS shall be designed to operate as a true on-line system in the following modes:
1. Normal - The critical AC load is continuously supplied by the UPS inverter. The input converter derives the power from a utility AC source and supplies DC power to the inverter. The UPS maintains the batteries in a fully charged state.
 2. Battery - Upon failure of utility AC power, extreme power surge, or extreme power drop, the critical AC load is supplied by the inverter, which obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
 3. Recharge – Upon restoration of utility AC power, after a utility AC power outage, the input converter shall automatically restart and resume supplying power to the inverter. The UPS shall resume normal operation and the battery charger shall recharge the battery.
 4. Automatic Restart – Upon restoration of utility AC power, after a utility AC power outage and complete battery discharge, the UPS shall automatically restart and resume supplying power to the critical load. Also the battery charger shall automatically recharge the battery.

2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Liebert, Inc.
 2. Eaton Corporation
 3. America Power Conversion (APC)

2.4 PERFORMANCE REQUIREMENTS

- A. The UPS shall have the following features and performance specifications:
1. Internal Battery: Sealed, lead-acid, maintenance free
 2. Input Power Factor: greater than .95, typical

3. Frequency: 50 or 60 Hz, auto-sensing
4. Frequency Range: 45-65 Hz
5. On Utility Voltage Regulation: +/- 3% of nominal
6. On Battery Voltage Regulation: +/- 3% of nominal
7. Efficiency: 89-92%, depending on load
8. Frequency Regulation: +/-3 Hz online; +/- 1 Hz on battery
9. Output Receptacles: (6) 5-15R
10. Input Connection: 5-15R
11. Reserve Time: 1500W minimum 7 minutes with ambient temperature of 77°F (25°C).
12. Reserve Time with (1) EBM: 1000W minimum 7 minutes with ambient temperature of 77°F (25°C).
13. Diagnostics: Full system self-test on power up.
14. UPS Bypass: Automatic on overload or UPS failure.
15. Serial Port: RS-232 port standard.
16. Surge Protection: IEEE/ANSI C62.41 Category B
17. Ambient Noise: less than 45 dBA (utility), less than 50 dBA (battery)
18. Ambient Operating: 32 to 104°F (0 to 40°C)
19. Recharge Time: Less than 2hrs. from complete discharge to 80% capacity at nominal line conditions.
20. The UPS shall be a Liebert GXT2-1500RT120 or equal.

PART 3- EXECUTION

3.1 GENERAL

- A. The UPS shall be installed in accordance with the equipment manufacturer's installation instructions.
- B. Detailed Requirements:
 1. The CONTRACTOR shall receive, store, and assemble all sections of the UPS to form complete units. The CONTRACTOR shall make all internal wiring interconnections as required for complete assembly of each UPS. Where wiring connectors are not supplied by the manufacturer the CONTRACTOR shall furnish the connectors required to complete internal wiring terminations.
 2. The CONTRACTOR shall take all necessary precautions to eliminate moisture and foreign material from the equipment at all times during storage and installation. Special care shall be taken to prevent corrosion of and damage to the UPS.

3.2 FIELD QUALITY CONTROL

- A. The following inspections and test procedures shall be performed by factory trained field service personnel during the UPS start-up.
 1. Visual Inspection
 2. Inspect equipment for signs of shipping or installation damage
 3. Verify installation per drawings
 4. Inspect cabinets for foreign objects

5. Verify neutral and ground conductors are properly sized and configured
6. Inspect battery cases
7. Inspect battery for proper polarity
8. Verify all printed circuit boards are configured properly

B. Mechanical Inspection:

1. Check all control wiring connections for tightness
2. Check all power wiring connections for tightness
3. Check all terminal screws, nuts, and/or spade lugs for tightness

C. Electrical Inspection

1. Check all fuses for continuity
2. Confirm input voltage and phase rotation is correct
3. Verify control transformer connections are correct for voltages being used
4. Assure connection and voltage of the battery string(s)

3.3 UNIT START-UP AND SITE TESTING

- A. Site testing shall be provided by the manufacturer's field service personnel if requested.
- B. Site testing shall consist of a complete test of the UPS system and the associated accessories supplied by the manufacturer. A partial battery discharge test shall be provided as part of the standard start-up procedure. The test results shall be documented, signed, and dated for future reference.

END OF SECTION 16611

SECTION 16723 – RADIO DISPATCH SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes multi-channel radio dispatch equipment, independent of telephone equipment. The system is existing (base station, antenna, tone remotes, and speakers). Additional tone remotes, speakers, and other equipment is being added to the system.
- B. Related Sections include the following:
 - 1. Division 16 SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS for general materials, installation, and labeling methods.
 - 2. Division 16 SECTION 16120 – CONDUCTORS AND CABLES

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the contract and Division 1 Specification Sections.
- B. Provide catalog cut sheets and data sheets for all products including, but not limited to, the following products:
 - 1. Tone remote controls
 - 2. Speakers
 - 3. Cabling
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, components, and location of each field connection.
- D. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single line diagram showing cabling interconnection of components.
- E. Installer Certificate: Signed by manufacturer certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of the equipment manufacturer for both installation and maintenance of equipment required for this Section.

- 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.
- C. Comply with NFPA 70 and UL 50.
- D. Comply with FCC emission requirements for VHF broadcast in the United States.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. VHF Antenna
 - a. TxRx Systems
 - 2. Base Station Radio
 - a. Motorola
 - 3. Tone Remote Controls
 - a. CPI Communications
 - 4. Speakers
 - a. Valcom
 - b. Electro-Voice
 - 5. Cabling
 - a. Belden
 - b. Times Microwave Systems

2.2 TONE REMOTE CONTROLS

- A. Description: Multi frequency telephone style tone remotes.
- B. Performance requirements:
 - 1. Line input: -20 dBm minimum
 - 2. Audio output impedance to speaker: 8 Ohms
 - 3. Connections: RJ11
- B. Microphones: Provide one tone remote with a desk microphone, and a minimum of two telephone style tone remotes.
- C. Power requirements: 120VAC

2.3 SPEAKERS

- A. Description: 15 Watt amplified horn shall be FCC registered, weather-resistant, high efficiency reentrant type horn with high frequency diffuser. It shall be equipped with an amplifier, externally accessible volume control. It shall include a detachable base for wall mounting.

- D. DeConstruction: High impact acrylonitrile butadiene styrene (ABS) plastic with LEXAN® base.
- C. Performance requirements:
 - 1. Frequency response: 250 Hz -14 kHz
 - 2. Horizontal Beamwidth: 120 degrees
 - 3. Vertical Beamwidth: 90 degrees
 - 4. Sound pressure level: 121 dB at 4' for an input of -10dBm @ 1kHz
 - 5. Impedance, Nominal: 8 ohms.
- D. Mounting: Detachable base for wall or single, double or octagon electrical box mounting and omni-directional ball joining mountin bracket to allow precise positioning in the vertical and horizontal planes with a single adjustment.
- E. Power requirements: 120 VAC

2.4 CABLING

- A. Description: Cabling shall be provided for the antenna feed and connections to the tone remotes.
- B. Performance requirements:
 - 1. Antenna feed: 50 OHM coaxial cable. LMR 400, Belden type 9913 or equivalent.
 - a. Termination at antenna: 7/16" Male DIN
 - b. Termination at base station: Male "N" Type
 - 2. Tone remote wiring: CAT 6 or equivalent
 - a. Termination at tone remote: RJ11 wall jack with faceplate.
 - b. Minimum of 2 twisted pairs routed to each tone remote.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install the base station equipment, antenna, and accessory items according to all written manufacturer instructions.

3.2 GROUNDING

- A. Make equipment grounding connections for wall cabinet and base station equipment as indicated in the plans and as required per code. Ensure antenna is properly grounded as indicated in the plans.

3.3 FIELD QUALITY CONTROL

- A. Testing: After installing of base station is complete, and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Test base station system for proper functionality per Manufacturer's recommendations. This includes testing the tone remotes and verifying transmit power output from the base station.
2. Correct malfunctioning equipment on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

3.4 CLEANING

- A. On completion of installation, inspect interior and exterior of wall cabinet. Remove dirt, and debris from within cabinet. Do not damage equipment. Touch up scratches and mars of finish to match original finish.

END OF SECTION 16723

SECTION 16780 – VIDEO SECURITY SYSTEM

PART 1- GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes fixed position camera systems. Provide the system as shown on the drawings and described in the specifications with no substitutions.

1.3 SYSTEM DESCRIPTION

- A. Provide a digital video security system with fixed cameras where indicated on the plans.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data: For each component specified, including detailed manufacturer's specifications. Include data on features, ratings, and performance. Include dimensioned plan and elevation views of components and enclosures. Show access and work-space requirements.
- C. Wiring Diagrams: Detailing internal and interconnecting wiring for power, signal, and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
- D. Maintenance Data: For camera systems to include in the maintenance manuals specified in Division 1. Include the following:
 - 1. Detailed operating instructions.
 - 2. Routine maintenance instructions.
 - 3. Lists of recommended spare parts and replacement components from the manufacturer.
- E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who is an authorized representative of the manufacturer. Installer shall be certified by the manufacturer of the camera system.
- B. Manufacturer Qualifications: Engage firms with 10 years minimum experience in manufacturing systems and equipment similar to those indicated for this Project and that have a record of successful in-service performance.

C. Listing and Labeling:

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
3. Comply with FCC regulations, including Parts 15, 17, 25, and 76.

D. Comply with NFPA 70.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the OWNER of other rights the OWNER may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the CONTRACTOR under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, executed by manufacturer and signed by both the manufacturer and Installer, agreeing to repair or replace components of the camera systems that fail in materials or workmanship within the specified warranty period.
 1. Warranty Period: 1 year from date of Substantial Completion.

1.7 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 1. Section 01810: Testing, Commissioning, and Training

PART 2- PRODUCTS

2.0 GENERAL

- A. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
- B. All systems and components shall have been thoroughly tested and proven in actual use. Exposed parts for cameras and housings to be used outdoors shall be stainless steel or aluminum. No painted steel.
- C. All systems and components shall be provided with the availability of a toll-free (U.S. and Canada), 24-hour technical assistance from the manufacturer. The technical assistance shall allow for immediate technical assistance for either the dealer/installer or

the end user at no charge for as long as the product is installed.

- D. The manufacturer on warranty and non-warranty items shall guarantee the repair and replacement of parts.

2.1 MANUFACTURERS

A. Manufacturers:

1. Pelco, Div. of Schneider Electric.
2. GE Security, Inc.

2.2 DIGITAL VIDEO RECORDER

The Digital Video Recorder with Ethernet connectivity shall require minimal training for the end user. The unit shall operate like a conventional multiplexer and VCR with local display monitor for live and playback viewing while the system continues to record new images. It shall be an integrated security system, capable of time division multiplexing multiple cameras and storing their digitized and compressed images on integral hard disk drives for fast search and retrieval either locally at the unit, or from a remote workstation using a Graphical User Interface (GUI).

A. The DVR shall meet or exceed the following design and performance specifications:

1. Recording: 16 analog video inputs at 30 images per second at 4CIF resolution.
2. Playback: 32 simultaneous streams while supporting 10 simultaneous queries.
3. Expandability: Up to 48 analog video inputs at 30 images per second at 4CIF resolution.
4. Fault tolerance: RAID 5 disk management across multiple hard disk drives. DVR shall be capable of simultaneously meeting the preceding specifications during an error or array rebuild. Drives shall be hot swappable and automatically configured when installed.
5. Power Supplies: 120VAC redundant supplies.
6. Alarm recording: Continuous scheduled alarm/event and motion recording.
 - a. Pre- and post-alarm recording.
 - i. Programmable on a per channel basis.
7. Video Signing: Digitally signing before being written to the hard disk drives.
8. Mounting: 19" EIA rack.
9. Storage: 1000 Gigabytes of video.
10. Certifications and ratings:
 - a. FCC, class A
 - b. CE, class A
 - c. UL Listed
11. DVR shall be PELCO DVR5104 or approved equal

2.3 CAMERA SYSTEM

The fixed cameras shall be indoor/outdoor, fixed mini dome system with a built-in 100BASE-TX network interface for live streaming MPEG-4 video at 30 images per second. Cameras will be powered by Power of Ethernet (PoE) (IEEE802.3af) and have thermostatically controlled heaters. Cameras shall have alarm inputs and outputs.

- A. The camera systems shall meet or exceed the following design and performance specifications:

1. Ports: RJ-45 connector for 100BASE-TX
2. Power consumption:
 - a. Without heater: <7.5 Watts
 - b. With heater: < 13 Watts
3. Compression: MPEG-4
4. Resolution: 4CIF, 720(H) x 540(V)
5. Dynamic Range 102 dB typical, 120 dB maximum
6. Minimum Illumination:
 - a. Color(day): 0.8 lux
 - b. B-W(night): 0.8 lux
7. Gain Control: Auto (33 dB minimum)
8. Day/Night Operation:
 - a. Day: Infrared cut filter
 - b. Night: No filter
9. Alarm Input: 10 VDC max, 5 mA max
10. Alarm Output: 15 VDC Max, 75 mA max
11. Operating temperature -50⁰ to 122⁰F; de-icing to 25⁰F
12. Angle of View
 - a. Horizontal: 100.4⁰ to 31.6⁰
 - b. Diagonal: 131.6⁰ to 39.6⁰
 - c. Vertical: 72.8⁰ to 23.8⁰
13. Certification and ratings:
 - a. CE, Class B
 - b. FCC, Class B
 - c. UL Listed
 - d. IEEE802.3af compliant
 - e. NEMA Type 4X and IP66 standard
14. Provide PELCO IP110 fixed cameras or approved equal.

2.4 NETWORK SWITCH

The network switch shall provide 24-port 10/100, 10/100/1000 ports and Power over Ethernet.

- A. The network switch shall meet or exceed the following design and performance specifications:

1. Connections
 - a. 100BASE-TX: 24 RJ-45
 - b. 1000BASE-T : 4 RJ-45
 - c. Cabling: CAT 6
2. Power over Ethernet
 - a. Power per port: 15 Watts min.
 - b. Power output all ports: 180 Watt min.
3. Switching Capacity: 12.8 Gbps, Non-Blocking
4. Mounting: 19" rack mountable
5. Operating Temp: 32⁰ to 104⁰F
5. Power: 120 VAC
6. Standards:
 - a. IEEE801.3 10BASE-T Ethernet

- b. IEEE802.3u 100BASE0TX Fast Ethernet,
 - c. IEEE802.3ab 1000BASE-T Gigabit Ethernet
 - d. IEEE802.3z Gigabit Ethernet,
 - e. IEEE802.3x Flow Control
 - f. IEEE802.3 ad LACP
 - g. IEEE802.3af POE
 - h. IEEE802.1d STP
 - i. IEEE802.1Q/p VLAN
 - j. IEEE802.1w Rapid STP
 - k. IEEE802.1s Multiple STP
 - l. IEEE802.1x Port Access Authentication
7. Provide LINKSYS SFE2000P or approved equal.

2.5 OTHER COMPONENTS

Other components of the video security system not described elsewhere in the specification include: equipment rack, cable connectors, camera mounting kits, rack accessories. Provide components that are compatible with the approved video cameras and digital video recorder manufacturer and authorized by the manufacturer where applicable. After market housings, etc, may not be acceptable if they do not provide the functionality, weather proof capabilities, heater, blower, etc. of the specified units. Provide products identified in the plans or approved equal.

2.5 MANUFACTURER'S WARRANTY

Repair or replacement of defective parts shall be for a period of one (1) year from the date of substantial completion, including continuous motion modes.

2.6 CERTIFICATIONS AND RATINGS

- A. CE and FCC, Class B (models with color cameras only)
- B. UL Listed
- C. UL Listed to Canadian safety standards
- D. Meets NEMA Type 4X and IP66 standards
- E. Tested in accordance with MIL-STD 810D as follows:
 - 1. Shock test; Section 516.4
 - 2. Humidity test; Sections 520.1 and 507.3
 - 3. Vibration test; Section 514.4
- F. ASTM Shipping Standard
- G. ISTA Shipping Standard

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with requirements for installation tolerances, power characteristics, and other conditions affecting performance of camera systems. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Install cameras in the locations indicated on the Plans.
- C. Provide an experienced, certified installer to set up each camera and the digital video recorder. Coordinate with the owner to set up the camera's pan, tilt, and zoom at each

location.

- D. Program the DVR to provide all of its features to the owner. Program all functionality and features of the system. Coordinate with owner to determine video retention times, resolution, and images per second. Program record on motion per owner requirements. Provide all software and additional equipment required to provide an operational system. Aim and adjust camera positioning as necessary.
- E. Provide at least 8 hours of training to owner's staff on basic setup, troubleshooting, programming and other standard training topics.
- F. Set up the system per the owner's requirements two weeks prior to substantial completion. Adjust the cameras, motion detection parameters, and other features and functions per the owner's requests and to eliminate false alarms during this two week period.

END OF SECTION 16780

SECTION 16851 – FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1. SUMMARY

- A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.
- B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.
- C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
 - 1. Fire alarm system detection and notification operations.
 - 2. Control and monitoring of smoke control equipment, fire suppression systems, and other equipment as indicated in the drawings and specifications.

1.2. DEFINITIONS

- A. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.3. SCOPE OF WORK

- A. The drawings and specifications detail the construction of a complete fire alarm system for the CBJ Consolidated Public Works Facility. A system shall be provided as shown and specified herein. This work incorporates all devices and equipment necessary for a fully functional fire alarm system. In addition, all necessary fire alarm device testing and code compliance requirements detailed elsewhere in the drawings and specifications shall be performed.

1.4. ACCEPTABLE EQUIPMENT AND SERVICE PROVIDERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Simplex Grinnell
- B. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.
- C. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
- D. The equipment and service provider shall be a nationally recognized company specializing in fire alarm and detection systems. This provider shall employ factory trained and NICET certified technicians. The equipment and service

provider shall have a minimum of 10 years experience in the fire protective signaling systems industry.

1.5. RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
 - 1. Division 16: "Basic Electrical Materials and Methods."
 - 2. Division 16: "Conductors and Cables."
 - 3. Division 16: "Raceways and Boxes."
 - 4. Division 16: "Wiring Devices."
 - 5. Division 16: "Grounding."
 - 6. Division 16: "Disconnect Switches and Circuit Breakers."
- C. The system and all associated operations shall be in accordance with the following:
 - 1. Requirements of the following Model Building Code: IBC, 2003 Edition
 - 2. NFPA 72, National Fire Alarm Code, 2002 Edition
 - 3. NFPA 70, National Electrical Code, 2005 Edition
 - 4. Local Jurisdictional Adopted Codes and Standards
 - 5. ADA Accessibility Guidelines

1.6. SYSTEM DESCRIPTION

- A. General: Provide a complete, non-coded addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein. Provide multiplexed signal transmission dedicated to fire alarm service only.
- B. The fire alarm system shall consist of all necessary hardware and software programming to perform the following functions:
 - 1. Fire alarm system detection and notification operations.
 - 2. Control and monitoring of smoke control equipment, door hold-open devices, fire suppression systems, emergency power systems, and other equipment as indicated in the drawings and specifications.
- C. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for all initiating device, signaling line, and notification-appliance circuits.
- D. Software: The fire alarm system shall allow for loading and editing instructions

and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new configuration download.

- E. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- F. Recording of Events: Record all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout differentiates alarm signals from all other printed indications.
- G. Wiring/Signal Transmission:
 - 1. Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation as required or addressable signal transmission, dedicated to fire alarm service only.
 - 2. System connections for initiating device circuits shall be Class B, Style C, signaling line circuits shall be Class B, Style 4 and notification appliance circuits shall be Class B, Style Y.
 - 3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.
- H. Remote Access:
 - 1. FACP shall have the capability to provide Remote Access through a Dial-Up Service Modem.
 - 2. A personal computer or technician's laptop, configured with terminal emulation software shall have the ability to access the FACP for diagnostics, maintenance reporting and information gathering.
 - 3. FACP shall have the capability to provide third party access through a serial interface connection and be agency listed for specific interfaces and for the purpose.
 - 4. FACP shall have the capability to provide remote access via an Internet/Intranet Interface. The Internet interface shall provide an alternative access to system information using the familiar interface of a standard Internet browser. A remotely located fire professional can use this access to analyze control panel status during non-alarm conditions and can also use this information to assist local fire responders during alarm conditions.
- I. Required Functions: The following are required system functions and operating features:
 - 1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm

events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.

2. Noninterfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
3. Transmission to an approved Supervising Station: Automatically route alarm, supervisory, and trouble signals to an approved supervising station service provider. Coordinate with the Ketchikan School District to connect to the monitoring system used at each school.
4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the type of device, the operational state of the device (i.e alarm, trouble or supervisory) and shall display the custom label associated with the device.
5. General Alarm: A system general alarm shall include:
 - a) Indication of alarm condition at the FACP and the annunciator(s).
 - b) Identification of the device /zone that is the source of the alarm at the FACP and the annunciator(s).
 - c) Operation of audible and visible notification appliances until silenced at FACP.
 - d) Closing doors normally held open by magnetic door holders.
 - e) Shutting down supply and return fans serving zone where alarm is initiated.
 - f) Closing smoke dampers on system serving zone where alarm is initiated.
 - g) Transmission of signal to the supervising station.
 - h) Initiation of elevator Phase I functions (recall, shunt trip, illumination of indicator in cab, etc.) in accordance with ASME/ANSI A17.1, when specified detectors or sensors are activated, as appropriate.
6. Supervisory Operations: Upon activation of a supervisory device such as a fire pump power failure, low air pressure switch, and tamper switch, the system shall operate as follows:
 - a) Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
 - b) Pressing the Supervisory Acknowledge Key will silence the

- supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
- c) Record the event in the FACP historical log.
 - d) Transmission of supervisory signal to the supervising station.
 - e) Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
7. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation.
 8. Visual notification appliances shall remain activated upon silencing-switch operation until the system is reset.
 9. System Reset: all devices are manually resettable from the FACP after initiating devices are restored to normal.
 - a) The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
 - b) Should an alarm condition continue, the system will remain in an alarmed state.
 10. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
 11. WALKTEST: The system shall have the capacity of 8 programmable pass code protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:
 - a) The city circuit connection and any suppression release circuits shall be bypassed for the testing group.
 - b) Control relay functions associated with one of the 8 testing groups shall be bypassed.
 - c) The control unit shall indicate a trouble condition.
 - d) The alarm activation of any initiating device in the testing group shall cause the audible notification appliances assigned only to that group to sound a code to identify the device or zone.
 - e) The unit shall automatically reset itself after signaling is complete.
 - f) Any opening of an initiating device or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.

- g) Removal of an alarm-initiating device or a notification appliance initiates the following:
 - 1. A "trouble" signal indication at the FACP and the annunciator for the device involved.
 - 2. Recording of the event by the system printer.
 - 3. Transmission of trouble signal to remote alarm receiving station.

12. All initiating device circuits and signaling line circuits shall not exceed 80 percent of circuit capacity. Provide additional panel capacity as necessary in order to meet this requirement.

J. Analog Smoke Sensors:

- 1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
- 2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
- 3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have several selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
- 4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT Display or printed for annual recording and logging of the calibration maintenance schedule.
- 5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to automatically indicate when a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate if a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a sensor approaching dirty without creating a trouble in the system. If this indicator is ignored and the second level is reached, a "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.
- 6. The FACP shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
- 7. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing

technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.2 to 3.7 %/ft obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.

8. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.
 9. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.
- K. Smoke Detectors: A maintenance and testing service providing the following shall be included with the base bid:
1. Biannual sensitivity reading and logging for each smoke sensor.
 2. Scheduled biannual threshold adjustments to maintain proper sensitivity for each smoke sensor.
 3. Threshold adjustment to any smoke sensor that has alarmed the system without the presence of particles of combustion.
 4. Scheduled biannual cleaning or replacement of each smoke detector or sensor within the system.
 5. Semi-annual functional testing of each smoke detector or sensor using the manufacturer's calibrated test tool.
 6. Written documentation of all testing, cleaning, replacing, threshold adjustment, and sensitivity reading for each smoke detector or sensor device within the system.
 7. The initial service included in the bid price shall provide the above listed procedures for a period of one year after owner acceptance of the system.
- L. Audible Alarm Notification: By horns in areas as indicated on drawings.
- M. Fire Suppression Monitoring:
1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
 2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
 3. WSO: Water flow switch and sprinkler valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.
- N. Power Requirements
1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
 2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon

power failure. All battery charging and recharging operations shall be automatic.

3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
5. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
8. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.7. SUBMITTALS

A. General: Submit the following according to Conditions of Contract.

1. Product data: For each type of product. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
2. Wiring diagrams from manufacturer. Differentiate between manufacturer-installed and field-installed wiring.
3. Shop drawings showing system details including location of FACP, all devices, circuiting and details of graphic annunciator. Provide schematic diagrams indicating how the individual devices are to be wired into the system. Provide the type and gauge of wire that is to be used to wire the system. This shall be performed by a NICET Level III certified technician.
4. System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate in accordance with the prescribed backup time periods and under all voltage conditions per UL and NFPA standards. This shall be performed by a NICET Level III certified technician.
5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location

or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.

6. Operating instructions for FACP.
7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
9. Record of field tests of system.
10. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
11. On a set of plan sheets showing floor plans with all devices shown in their installation locations a point-to-point wiring diagram indicating the end of line (EOL) location, the order that the devices are connected into the system, and the zone they are included in. This shall be performed by a NICET Level III certified technician.
12. Provide a riser diagram with the quantity and type of devices per circuit/zone. This shall be performed by a NICET Level III certified technician.
13. Provide quantity of signaling devices, current consumption, and EOL voltage for each circuit. Determine candela requirements for all strobes and horn strobes. Show candela rating on wiring diagram. This shall be performed by a NICET Level III certified technician.
14. Provide six sets of bound, indexed, and tabbed fire alarm submittals.
15. Provide a complete list of all device "names" that will be used on the annunciator panels. Show names on plan sheets so OWNER can verify appropriate names. Change names as directed by OWNER.

- B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions, if required, to make clarifications or revisions to obtain approval.

1.8. QUALITY ASSURANCE

- A. Installer Qualifications: A factory authorized installer is to perform the work of this section.
- B. Each and every item of the Fire Alarm System shall be listed under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.
- C. Source Limitations: Obtain all fire alarm system components through one source

from a single manufacturer.

1.9. MAINTENANCE SERVICE

- A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.
- B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
- C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.
- D. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

1.10. EXTRA MATERIALS

- A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
 - 1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
 - 2. Notification Appliances: Furnish quantity equal to 10 percent of each type and number of units installed, but not less than one of each type.
 - 3. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of each type and number of units installed but not less than one of each type.
 - 4. Detector or Sensor Bases: Furnish quantity equal to 2 percent of each type and number of units installed but not less than one of each type.
 - 5. Circuit Interface Modules: Furnish quantity equal to 10 percent of each type and number of units installed, but not less than one of each type.
 - 6. Device Wire Guards: Furnish quantity equal to 10 percent of number of units installed, but not less than one of each type.
 - 7. Tamper Alarm Shields: Furnish quantity equal to 10 percent of each type and number of units installed, but not less than one of each type.
 - 8. Fire Alarm Panel Keys: Furnish five sets of keys for each type of panel installed at each project location.
 - 9. Magnetic Testing Device: Furnish quantity equal to 10 percent of each type

of smoke detector and number of units installed, but not less than one of each type.

10. Printer Ribbons: Furnish 6 spare printer ribbons.

PART 2 – PRODUCTS

2.1. FIRE ALARM CONTROL PANEL (FACP)

- A. General: Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems".
- B. The following FACP hardware shall be provided:
 - 1. Power Limited base panel with red cabinet and door, 120 VAC input power.
 - 2. 2,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
 - 3. 2,000 points of Network Annunciation at FACP Display when applied as a Network Node.
 - 4. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FACP LCD Display.
 - 5. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output.
 - 6. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
 - 7. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
 - 8. Three (3) Class B or A (Style Y/Z) Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
 - 9. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
 - 10. The FACP shall support (6) RS-232-C ports and one service port.
 - 11. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
 - 12. Programmable DACT for either Common Event Reporting or per Point Reporting.
 - 13. Service Port Modem for dial in passcode access to all fire control panel information.
- C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures. Identify

individual components and modules within cabinets with permanent labels.

- D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands. Specifications:

1. The system shall include the necessary hardware to provide expanded content, multi-line, operator interface displays. The expanded content multi-line displays shall be Quarter-VGA (QVGA) or larger and be capable of supporting a minimum of 854 standard ASCII characters to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions. The QVGA operator interface shall provide operator prompts and six context sensitive soft-keys for intuitive operation.

- a) Expanded content, multi-line operator interfaces shall be capable of providing the following functions:

- (a) Activity display choices for:

- (i) First 8 Events.

- (ii) First 5 Events and Most Recent Event (with first and most recent event time and date stamps).

- (iii) First Event and Most Recent Event (with first and most recent event time and date stamps).

- (iv) General Event Status (alarm, priority 2, supervisory, or trouble in system)

- (v) Site Plan

- (b) Equal or hierarchal priority assignment. In systems with two or more operator interfaces, each operator interface shall be programmable to allow multiple operator interfaces to have equal operation priority or to allow hierarchal priority control to be assigned to individual operator interfaces (locations).

- (c) Up to 50 custom point detail messages for providing additional point specific information in detailed point status screens.

- (d) Bitmap file import for operator interface display of site plan and background watermark images.

2.2. REMOTE CRTS, PC ANNUNCIATOR AND PRINTERs

- A. Fire Alarm Control Unit shall be capable of operating remote CRT's and/or printers; output shall be ASCII from an RS-232-C connection with an adjustable baud rate.
- B. Fire Alarm Control Unit shall be capable of operating a PC Annunciator which provides status annunciation and limited system control using a convenient and familiar Microsoft Windows® 2000 operating system based interface. PC Annunciator shall provide the following functions:
 - 1. Login/logout password protection with time duration selectable automatic logout.
 - 2. Display Alarm, Supervisory, Priority 2, and Trouble conditions with numerical tallies for each.
 - 3. Display first and last alarms.
 - 4. Different event types have separate visible indicators with a common audible indicator.
 - 5. Event logs can be searched and printed.
 - 6. View and/or print alarm status reports and service reports (printing requires an available local or network printer).
 - 7. Alarm Silence; System Reset; and Priority 2 Reset.
 - 8. Global and individual point acknowledge.
 - 9. Set system time and date and clear event log.
 - 10. Individual point access for control or parameter revisions.
 - 11. WALKTEST system test is supported for service convenience.
- C. Each RS-232-C port shall be capable of supporting and supervising a remote Printer; the FACP shall support as many as two (2) remote displays. The Fire Alarm Control Panel shall support five (5) RS-232-C ports.

2.3. REMOTE ANNUNCIATOR - LCD TYPE

- A. Provide a remote LCD annunciator with the same “look and feel” as the FACP operator interface. The remote LCD annunciator shall use the same primary acknowledge, silence, and reset keys; status LEDs and LCD display as the FACP.
- B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.
- C. Under normal conditions the LCD shall display a “SYSTEM IS NORMAL” message and the current time and date.
- D. Should an abnormal condition be detected the appropriate LED (alarm, supervisory, or trouble) shall flash. The unit audible signal shall pulse for alarm

conditions and sound steady for trouble and supervisory conditions.

- E. The LCD shall display the following information relative to the abnormal condition of a point in the system:
 - 1. 40 character custom location label.
 - 2. Type of device (e.g., smoke, pull station, waterflow)
 - 3. Point status (e.g., alarm, trouble).
- F. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, silence, and reset operations shall be the same as the FACP.

2.4. SYSTEM PRINTER

- A. General: Provide a dot-matrix type, listed and labeled as an integral part of the fire alarm system at Capitol Annex. Coordinate location with OWNER. Provide shelf and associated hardware to mount the printer on.

2.5. EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for a period of 5 minutes.
- C. Battery Charger: Solid-state, fully automatic, variable-charging rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.
- D. Integral Automatic Transfer Switch: Transfer the load to the battery without loss of signals or status indications when normal power fails.

2.6. ADDRESSABLE MANUAL PULL STATIONS

- A. Description: Addressable single- or double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
- B. Protective Shield: Where required, as indicated on the drawings, provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering

and realigning the shield. The horn shall provide 95dB at 1 feet and shall be powered by a 9 VDC battery.

2.7. SMOKE SENSORS

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 - 1. The address for each smoke detector shall be programmed in the base of each smoke detector, not in the device itself. A device shall be able to be replaced without having to perform any programming.
 - 2. Factory Nameplate: Serial number and type identification.
 - 3. Operating Voltage: 24 VDC, nominal.
 - 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 - 5. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
 - 6. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
 - 7. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 - 8. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
 - 9. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI.
 - 10. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
 - 11. Removal of the sensor head for cleaning shall not require the setting of addresses.
- B. Type: Smoke sensors shall be of the photoelectric type.
- C. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.

2.8. HEAT SENSORS

- A. The address for each heat detector shall be programmed in the base of each heat detector, not in the device itself. A device shall be able to be replaced without having to perform any programming.
- B. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- C. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
- D. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.
- E. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.
- F. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
- G. Removal of the sensor head for cleaning shall not require the setting of addresses.

2.9. ADDRESSABLE CIRCUIT INTERFACE MODULES (CIM)

- A. Addressable Circuit Interface Modules: Provide modules as integrated input / output devices for controlling and monitoring non-addressable fire alarm devices. Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, hood exhaust systems, non-addressable devices, and for shut down of AHU systems. All new smoke and heat detectors, duct detectors, and manual pull stations shall be addressable.
- B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the initiating device circuit, signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.
- C. All Circuit Interface Modules shall be supervised and uniquely identified by the control panel. Module identification shall be transmitted to the control panel for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and

communicating.

2.10. ALARM NOTIFICATION APPLIANCES

- A. Horn: Piezoelectric type horn shall be listed to UL 464. The horn shall have a minimum sound pressure level of 85 dBA at 10 feet @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings.
- B. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. V/O appliances shall be provided with minimum flash intensity of 75cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance. Provide horn strobes with candela rating as required to meet NFPA 72 requirements for the location the strobe is being installed.
- C. Audible/Visible: Provide minimum flash intensity 75cd horn strobes. Provide horn strobes with candela rating as required to meet NFPA 72 requirements for the location the strobe is being installed. Combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 85 dBA at 10 feet @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings.
- D. Notification Appliance Circuit provides synchronization of strobes at a rate of 1Hz and operates horns with a Temporal Code Pattern operation. The circuit shall provide the capability to silence the audible signals, while the strobes continue to flash, over a single pair of wires. The capability to synchronize multiple notification appliance circuits shall be provided.
- E. Accessories: The contractor shall furnish any necessary accessories.

2.11. DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Listed and labeled under UL 864 and NFPA 72.
- B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, the unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

- C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
- D. Self Test: Conducted automatically every 24 hours with report transmitted to the central station.

PART 3 – EXECUTION

3.1. INSTALLATION, GENERAL

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.
- B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
 - 1. Factory trained and certified personnel.
 - 2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 - 3. Personnel licensed or certified by state or local authority.

3.2. EQUIPMENT INSTALLATION

- A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.
- B. Equipment Removal: Disconnect and remove the existing fire alarm equipment and devices as they are replaced during construction. Restore damaged surfaces as equipment and devices are replaced and installed. Package operational fire alarm and detection equipment that has been removed and deliver to the OWNER. Remove from the site and legally dispose of the remainder of the existing material. Restore all damaged surfaces.
- C. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.
- D. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.
- E. Install manual station with operating handle 48 inches (1.22 m) above floor. Install wall mounted audible and visual notification appliances not less than 80 inches (2.03 m) above floor to bottom of lens and not greater than 96 inches (2.44 m) above floor to bottom of lens. Replace existing devices at their current location unless noted otherwise.

- F. Ceiling-Mounted Smoke Detectors: Not less than 4 inches (100 mm) from a side wall to the near edge. On smooth ceilings, install not more than 30 feet (9 m) apart in any direction.
- G. Wall-Mounted Smoke Detectors: At least 4 inches (100 mm), but not more than 12 inches (300 mm), below the ceiling.
- H. Smoke Detectors near Air Registers: Install no closer than 60 inches (1520 mm)
- I. Duct Smoke Detectors: Comply with manufacturer's written instructions.
 - 1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 2. Install sampling tubes so they extend the full width of the duct.
- J. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- K. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control panels, and duct smoke detectors. Add addressable circuit interface modules at each device.
- L. Automatic Detector Installation: Conform to NFPA 72.

3.3. PREPARATION

- A. Coordinate work of this Section with other affected work.

3.4. WIRING INSTALLATION

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction, shall be as shown on the drawings, and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC). Install wiring in metal raceway according to Division 16 Section 16130 "Raceways and Boxes." Conceal raceway except in unfinished spaces and as indicated.
- B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.
- D. Mount end-of-line device in box with last device or separate box adjacent to last device for Class "B" supervision.

3.5. FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Service personnel shall be qualified and experienced in the installation inspection, testing, and maintenance of fire alarm systems, with the following qualifications:
 - 1. Factory trained and certified on the system to be installed.
 - 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified, Level II.
 - 3. Licensed by State of Alaska to perform fire alarm installations.
- C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting.
- D. Inspection:
 - 1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
 - 2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
- E. Acceptance Operational Tests:
 - 1. Perform operational system tests to verify conformance with specifications:
 - a) Each alarm initiating device installed shall be operationally tested. Each device shall be tested for alarm and trouble conditions. Contractor shall submit a written certification that the Fire Alarm System installation is complete including all punch-list items. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified. Test Supervising Station Signal Transmitter. Coordinate testing with Supervising Station monitoring firm/entity.
 - b) Test each Notification Appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
 - c) Test Fire Alarm Control Panel and Remote Annunciator.
 - 2. Provide minimum 10 days notice of acceptance test performance schedule to Owner, and local Authority Having Jurisdiction.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests,

and detailed test results in the form of a test log. Use NFPA 72 Forms for documentation.

H. Final Test, Record of Completion, and Certificate of Occupancy:

1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.

3.6. CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.7. TRAINING

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
 1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
 2. Schedule training with the Owner at least seven days in advance.
 3. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.

END OF SECTION 16851

SECTION 16856 – ELECTRIC HEAT TRACE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install a complete UL Listed heat tracing system to prevent roof drains from being clogged with ice and snow, including heaters, components, controls and accessories.

1.2 SUBMITTALS

- A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- B. Catalog Cut Sheets: Provide product data on all equipment including installation instructions.
- C. In addition, provide the following submittal information:
 - 1. System design calculations
 - 2. General Wiring Schematics
 - 3. Installation and maintenance check list
 - 4. Operation and Maintenance Manuals
 - 5. UL certification documents

1.3 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NFPA 70, UBC, NESC, and all local, state, and federal regulations.
- C. Comply with IEEE-515-1: "Recommended Practice for Electrical Resistance Heat Tracing for Commercial Applications"

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26.

1.5 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by ENGINEER.

1.6 COORDINATION WITH COMMISSIONING

- A. Upon completion of the work, provide the necessary skilled labor, helpers, materials and equipment to support the commissioning work. During start-up, testing and final verification, coordinate with the commissioning agent and make all adjustments required to demonstrate systems are working properly. Correct any deficiencies in the work found by the commissioning agent.
- B. See the following Division 1 Section for all commissioning requirements related to the work of this Section.
 - 1. Section 01810: Testing, Commissioning, and Training

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Roof Drain De-icing Systems, Inc.
 - 2. Nelson Heat Tracing Systems, Inc.

2.2 HEAT TRACE CABLE

- A. Heater cable parallel self regulating with radiation cross-linked heating core extruded continuously over two parallel bus wires. The heating cable shall vary power output inversely with temperature such that power output decreases as pipe temperature increases. The cable output shall be lower than 30% of it's rating when it's temperature exceeds 60 degrees F. The heat trace cable shall have a maximum surface (maintenance) temperature of 150 degrees F.
- B. Heater construction shall included a radiation cross linked inner jacket thermally bonded to the heating core, a polyolefin dielectric jacket, tinned copper braid and UV stabilized, modified polyolefin outer jacket.
- C. Heat tracing cable manufacturer shall manufacture their own heat trace cables. Provide with all connectors, end kits, etc.
- D. Heater and component selection shall be consistent with manufacturer's published recommendations.

2.3 HEAT TRACE CONTROLS AND MONITORING

- A. The system shall be controlled via a contactor set to energize the heat tracing with low ambient temperature. Sensor shall trigger a contactor to energize the heat trace cables as described in the plans.

PART 3 - EXECUTION

- A. Install heater cable in star pattern around drains and loop down minimum 2 feet in each drain.
- B. Feed heater cable through roof via galvanized conduit. Provide weatherproofing compound around all roof penetrations per Architectural.
- B. Attach heater to roof clips attached to membrane roof with adhesive. Select adhesive approved by membrane roof manufacture.
- C. All heater circuits shall have 30mA ground fault protection.
- D. The heater shall be meggered at 500-2,500 VDC (1) after installation. Minimum insulation resistance is 20 megohms regardless of heater length.

END OF SECTION 16856